the REFINER AND NATURAL GASOLINE MANUFACTURER

Complete ELLIOTT Vacuum Producing *and* Condensing Unit

for accomplishing steam distillation at low absolute pressures. This unit is typical of many in successful operation.

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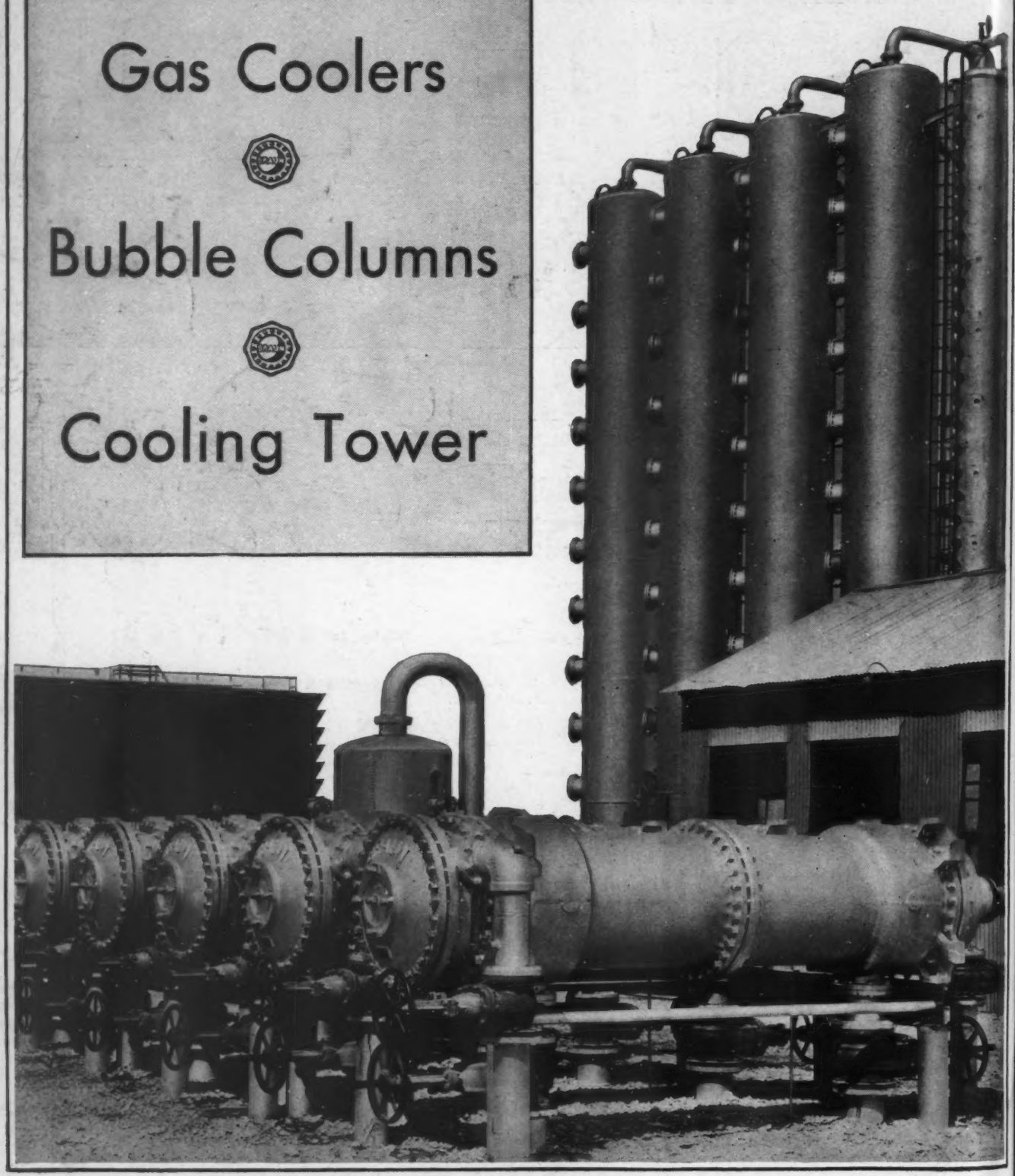
Gas Coolers

Bubble Columns

Cooling Tower



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Safe HIGH TEMPERATURE OPERATION

COMBINATION of high temperature and pressure requires exceptionally close control of every step in valve manufacture. Shrinkage cracks and strains, porosity, segregation and other defects are commonly found in cast steel unless every foundry operation is under the direct control of trained metallurgists and highly technical steel foundry operators.

Reading Steel Valves and Fittings are the result of years of research in foundry practice. Modern machining methods—thorough inspection and rigid tests are your assurance that Reading Steel Valves and Fittings are better than average. You are safe when you specify "READING."

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READING *for* steel
PRATT & CADY *for* iron *and* bronze
specializing for quality valves and fittings
"There can be no compromise with safety"

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AN ASSOCIATE COMPANY OF AMERICAN CHAIN COMPANY, Inc.
In Business for Your Safety

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Electric Cast Steel
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C. H. WHEELER

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1. High heat transfer rate.
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5. Removable tube bundle.
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Made in all sizes for any Vacuum or Pressure

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☐ The "Pumpkinseed type" CAMPBELL Steam Flow Controller.
☐ The Tar Baby Burner. (Handles Fuel Oils, Water Gas Tar, Acid Sludge, and Residue Fuels.)

At the left we show the "Watermelon type" Controller. Positively controls, indicates, and records steam flow at the desired rate. Guesswork eliminated. Saves steam, fuel, and labor.

What is your control problem?

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Without obligating me, please send complete information on your products which I have checked above.
Name .....
Firm .....
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THE MONTH IN REVIEW

In the following columns will be found a brief digest of happenings of interest to refiners, with even reference to a rumor or two!

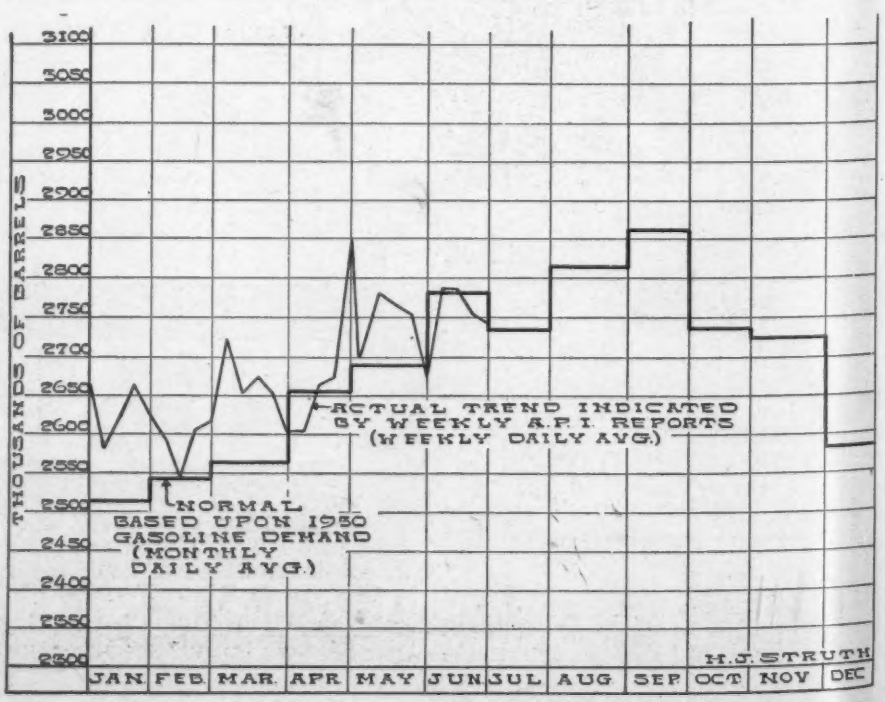
DRILLING during June showed a marked decline. Well completions during that month aggregated 1679 against 1973 in May. Initial oil production consequently declined materially, the total for June aggregating 580,997 barrels against 771,977 barrels in May. Practically all producing states reported fewer well completions during June and markedly lower initial oil production. Field development in California has subsided to mere routine work with the result that only 56 wells were completed in that state during June, contributing only 22,610 barrels of new oil production.

GASOLINE consumption during April was up 14.2 per cent over the same period of last year, according to figures prepared by the American Petroleum Institute. Data covering gasoline consumption, based upon state tax returns for 42 states, shows that 918,649,000 gallons were consumed during April, compared with 804,685,000 gallons during April, 1929. Total consumption for the first four months of this year aggregated 3,068,247,000 gallons, compared with 2,725,470,000 gallons during the same period of last year. The increase in gallonage for April over the same month of last year amounted to 113,964,000 gallons. For the four-month period, compared with last year, the increase in gallonage amounted to 342,777,000 gallons.

FURTHER improvement in the crude situation was shown during June when the daily average production for the United States continued its downward trend. Total production of crude during June was 77,806,900 barrels, a daily average of 2,593,500 barrels. This compares with a total of 80,524,000 barrels in May, or a daily average of 2,597,700 barrels. California staged a further decline in June, production dropping to a new low figure for this year of 598,000 barrels daily.

IMPORTS of crude petroleum dur- ing May, according to the Bureau of Mines, amounted to 4,948,000 barrels, against 5,781,000 barrels in May. Refined oil imports were 3,603,000 barrels, against 3,214,000 barrels in May. For the first five months of this year imports of crude aggregated 25,363,000 barrels, compared with 37,261,000 barrels for the same period of last year. Refined oil imports for this same period aggregated 17,560,000 barrels, against 8,647,000 barrels in 1929. A record of gasoline im-

RUNS OF CRUDE OIL TO STILLS



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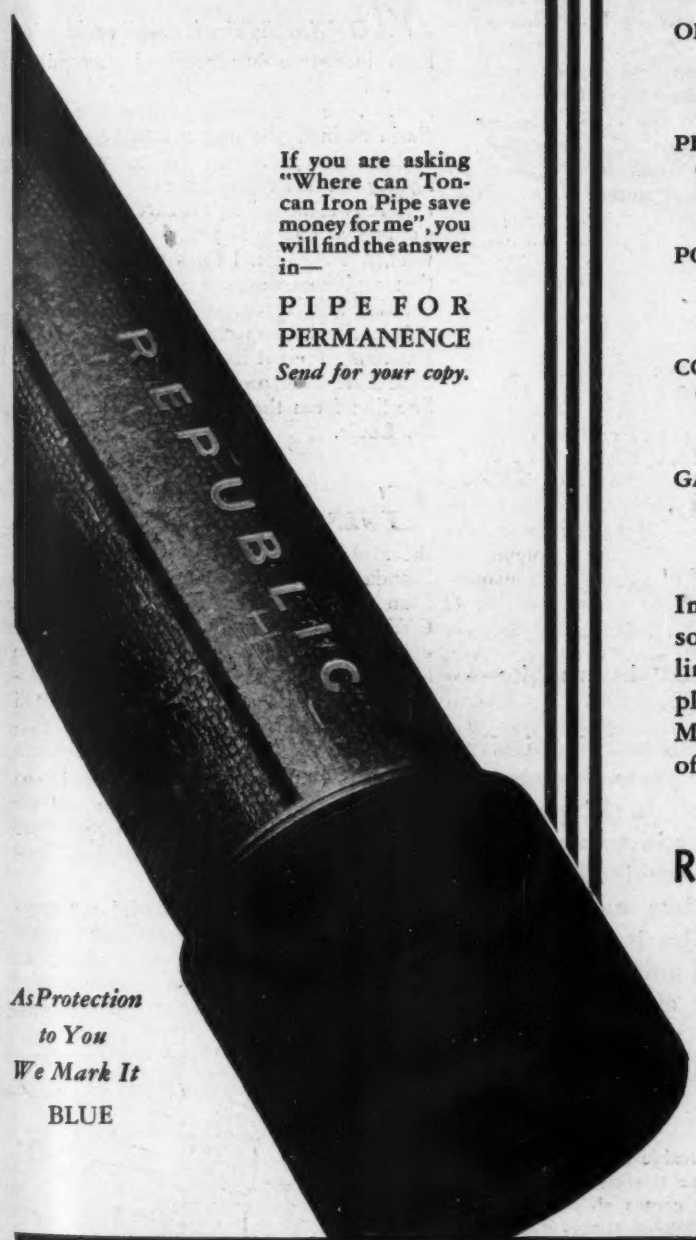
IRON PIPE



If you are asking "Where can Toncan Iron Pipe save money for me", you will find the answer in—

PIPE FOR PERMANENCE

Send for your copy.

As Protection to You We Mark It BLUE

IS WRITING NEW RECORDS IN MANY INDUSTRIES

REFINERY	"Toncan has relieved us of corrosion troubles where shut-downs for repairs are costly."
OIL COMPANY	"used to pull tubing about twice a year—severe conditions—Toncan in service over fifteen months."
PIPE BENDING COMPANY	"because of failure of coils of other ferrous material—now using coils of Toncan Iron Pipe."
POWER PLANT	"under severe corrosive conditions installed Toncan Line—free from attack despite long service."
COAL MINING COMPANY	"17 months comparative test in acid mine water. Only Toncan Pipe suitable for use after tests."
GAS COMPANY	"is now using Toncan Pipe under streets in highly corrosive soils to save heavy replacement expense."

In steam and water lines,—exposed or buried in corrosive soil,—in coolers, heaters, condensers and connecting lines—in severe service in mills, mines and industrial plants the country over—Toncan Iron Pipe—the Copper Molybdenum Iron Alloy Pipe—is writing new records of longer life, trouble free service and lower ultimate costs.

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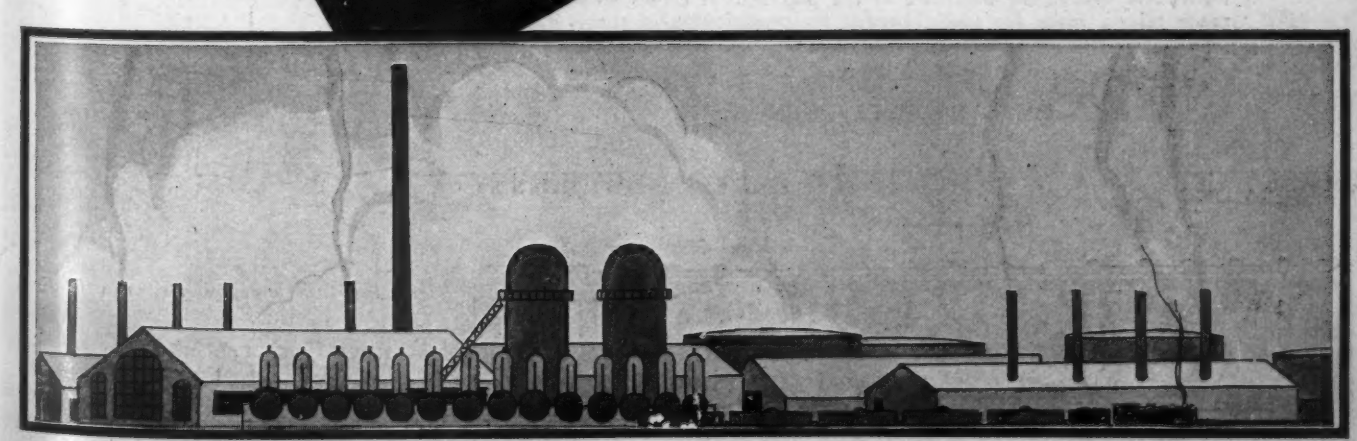

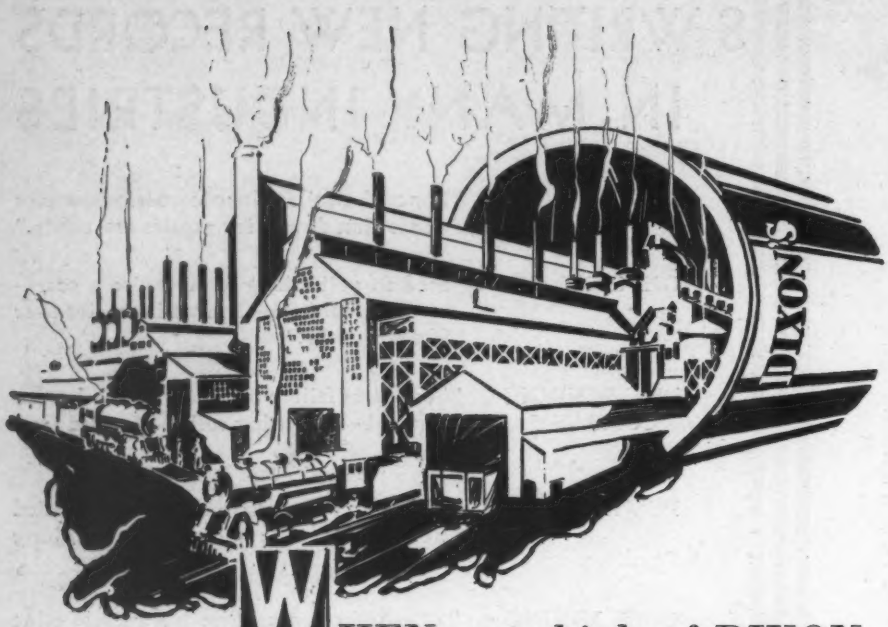

WHEN you think of DIXON you think of GRAPHITE..

And when you think of paint you think of PIGMENT

So it's logical that Dixon's Industrial Paint should contain graphite—FLAKE SLICA-GRAPHITE as its basic pigment.

Flake graphite, by virtue of its inherent water repellent and chemically inert qualities, is recognized as the ideal pigment for protecting metal. Silica gives flake graphite still greater endurance. In Dixon's Industrial Paint, this combination of graphite and silica is a natural one—they are mined together, and not mechanically combined. Nature has provided a stronger and more effective mixture than man has been able to achieve. Dixon takes Nature's gift and applies it, with boiled linseed oil, as the vehicle for the benefit of mankind and industry—to fight man's battles with Nature, and against other elements of corrosion.

Dixon's Industrial Paint is made in 14 colors. Write for Color Card 99-BI.

Dixon's Bright Aluminum Paint contains a most durable spar varnish as its vehicle which gives great resistance to the elements and insures the brilliance of the pigment. It comes already mixed, ready for use. There is no precipitation of the pigment. Write for Color Card No. 99-BA.

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DIXON'S INDUSTRIAL SILICA GRAPHITE PAINT

The Month in Review

ports for the first five months of this year shows a gain over last year of more than 3,700,000 barrels. The total thus far in the year aggregated 6,488,000 barrels, against 2,783,000 barrels last year.

MOVEMENT of gasoline in pipe lines interstate has received recognition from the Interstate Commerce Commission. Pipe line companies handling traffic in refined products are to be required to make reports to the governmental agency on such movement. So far the traffic is confined to Tuscarora Pipe Line Company from Bayway, New Jersey, west, but additional lines under construction and contemplated will mean a substantial volume of such movement. Republic Steel Corporation has order for 500 tons of eight-inch pipe from Phillips Pipe Line Company for its 800-mile gasoline line from the Panhandle of Texas to St. Louis.

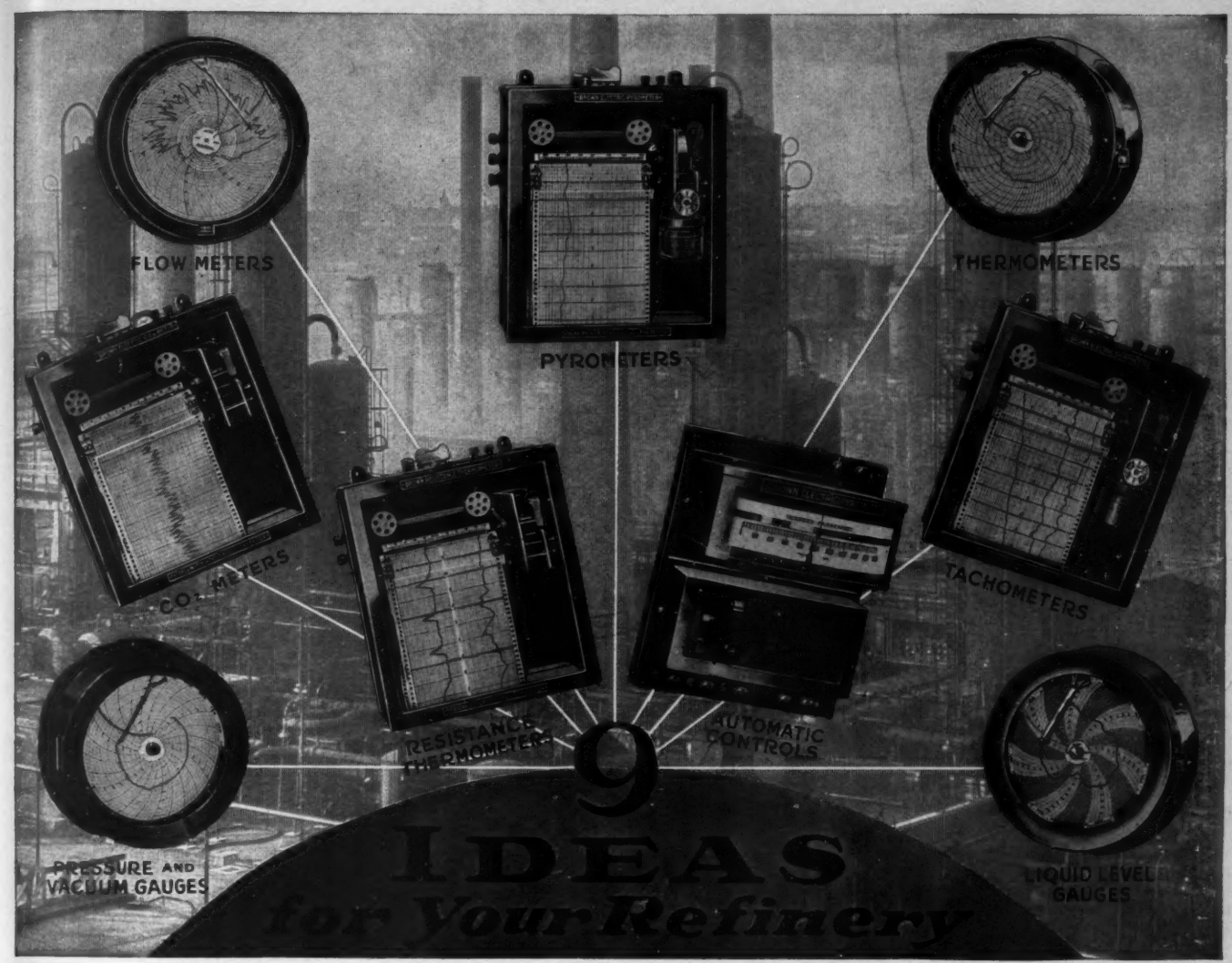
GULF Oil Corporation will enter the Middle West in competition with the Standard Oil Company (Indiana) and Standard Oil Company of Ohio. The Gulf announcement June 14 was to the effect that Union Gulf Pipe Line will be built from Perryman, Oklahoma, to Pittsburgh, Pennsylvania, center of Gulf Oil Corporation interests, touching at Cincinnati and Toledo, Ohio.

Three refineries were announced, one at Cincinnati, one at Pittsburgh and the third presumably at Toledo, where Gulf recently bought Paragon Refining Company.

While the announcement did not mention distribution, the assumption is that the orange disc will be seen along the highways of this territory as soon as pipe line and refining facilities are complete.

Gulf line to new refining sites in the East

Apparently the announcement of the new line will set at rest definitely rumors of merger between Gulf Oil Corporation and Standard Oil Company of



FLOW METERS

For indicating, recording and controlling the flow of oil, gasoline, gas, steam, water, air and other liquids, gases or vapors encountered in the production, refining and transportation of petroleum and petroleum products.

AUTOMATIC CONTROLS

For automatically controlling, within desired limits, temperatures, pressures, flows, tower levels, speeds and % CO_2.

THERMOMETERS

For indicating, recording and controlling temperatures ranging up to 800° F. where the instruments may be located at relatively short distances from the points where the temperatures are to be taken.

CO_2 METERS

For indicating, recording and controlling % CO_2 in still and boiler furnace to check and insure proper firing efficiency.

PYROMETERS

For indicating, recording and controlling temperatures in stills, towers, furnaces, flues, lines, etc., in and around the oil refinery.

RESISTANCE THERMOMETERS

For indicating, recording and controlling low temperatures such as are encountered in de-waxing plants.

TACHOMETERS

For indicating, recording and controlling speeds of pumps, fans and other machines in the refinery.

PRESSURE AND VACUUM GAUGES

For indicating, recording and controlling pressures and vacuums in stills, towers, steam and power plants, etc., in and around the oil refinery.

LIQUID LEVEL GAUGES

For indicating, recording and controlling the level of petroleum and petroleum liquid products in tanks, towers, etc., at a distance.

Write for Data

THE BROWN INSTRUMENT COMPANY

4498 Wayne Ave., Philadelphia, Pa.

Branches in 20 principal cities.

Brown Instruments

"to measure is to economize"

An airplane view of part of a refining plant at Ponca City, Oklahoma, showing our cooling tower. This tower is 60 feet high.

Cooling Water From 150 Degrees to 74 Degrees

THE 70 degree wet bulb is the July average for Oklahoma. Our problem was to design a cooling tower which would cool water going on the tower at temperatures from 125 degrees to 150 degrees to a point within 5 degrees of the wet-bulb, cooling over a range as much as 75 degrees.

The solution to the problem was a cooling tower 60 feet high with twenty decks. That cooling tower was installed almost four years ago, and the results to date have been entirely satisfactory. Records have been kept of the daily and often hourly performance of this tower, and true wet-bulbs have been taken with a sling psychrometer as well as stationary wet-bulb readings, so that the performance of the tower has been checked in every way against the cooling results it was designed to accomplish.

Not every refining plant has a water cooling problem like this. We cite this merely to show that our engineering department can handle difficult assignments when necessary. Ordinarily our Standard Type Cooling Towers will meet your requirements perfectly. They are described in our Bulletin 283-R, a copy of which will be sent on request.

THE COOLING TOWER COMPANY, INC.

15 JOHN STREET, NEW YORK

Representatives in Principal Cities

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Whealton & Townsend, Inc.,
120 E. Brady St.

HOUSTON
J. A. Rossiter Company
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45 CAMPBELL Boiler Feed Water Regulators in one Refinery *(name on request)*

(Patented)

The Campbell maintains correct water level regardless of load. Campbell regulators slow down the feed on sudden load increases; they quickly restore the water level when the steam demand decreases. Simple. Accurate. Dependable. Entirely new principle. Costs less to install and maintain than any other regulator. Any mechanic who can cut and fit pipe can install it. Let us tell you what it is doing in other refineries.

On which of these Atlas products do you want information?

- ☐ Feed Water Regulators
- ☐ Reducing Valves
- ☐ Damper Regulators
- ☐ Temperature Regulators
- ☐ Pump Governors
- ☐ Float Valves
- ☐ Swing Joint Fittings
- ☐ Bronze Unions
- ☐ Thermostats
- ☐ Balanced Valves

ATLAS VALVE CO., 275 South Street Newark, N. J.

Indiana, which rumors have come up intermittently for several years.

The last paragraph of President Mellon's statement, in which he says, "it will also enable the company to reach economically territory which it does not serve," is significant.

Mr. Mellon's statement follows:

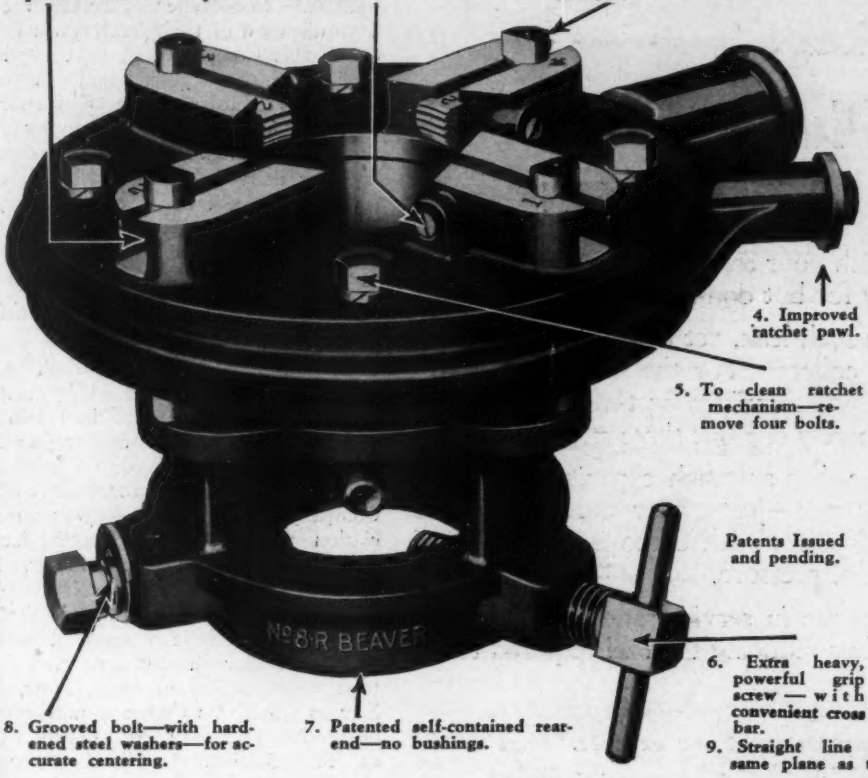
"The plan of Union Gulf Corporation is considered by directors of Gulf Oil Corporation to be the most convenient and economical means to enable Gulf Oil Corporation to utilize fully the large production of its subsidiaries in Mid-Continent, Louisiana, Arkansas and Texas fields in directly supplying the company's present marketing facilities and to promote the growth and expansion of the company's business in the territory east of the Mississippi River, particularly in Western Pennsylvania and in the states bordering on Ohio River and the Great Lakes.

"The new pipe line to be built from Eastern Oklahoma to serve the new refineries to be erected at Pittsburgh, Cincinnati and Toledo will connect with the Gulf Corporation's general pipe line system near Tulsa. In view of existing freight rates, this should mean a very substantial saving over the Gulf Oil Corporation's present method of shipping refined products by rail from its present refineries into the territory east of the Mississippi River. It also will enable the company to reach economically territory which it does not serve."

COMPLETION of Ajax Pipe Line

Company's line from Oklahoma to Wood River, Illinois, scheduled for the end of the present year, will occasion a change in source of crude for a number of Eastern refineries: Ajax Pipe Line Company, wholly owned subsidiary of Standard Oil Company of New Jersey, will build 375 miles of twin 10-inch line with capacity of 65,000 barrels daily which will be secured from Carter Oil Company, New Jersey subsidiary in Oklahoma, and delivered to existing lines of New Jersey subsidiaries. This is calculated to leave Prairie Pipe Line Company out of the picture as regards delivery of crude to lines eastward from the Mississippi. This prospect revives plans for merging of Sinclair Consolidated Oil Corporation and Prairie Oil & Gas Company, under which arrangement Sinclair would have the Prairie pipe from the Mid-Continent to Chicago territory, and would dispose of its half interest in Sinclair Pipe Line Company to Standard Oil Company (Indiana), the latter to then operate that line for its exclusive benefits. The Indiana company has been active in building up additional crude supplies of its own in the Mid-Continent, which may be substantiation of this supposition. Principal customers of Prairie Pipe Line Company scheduled to be alienated under the Ajax Pipe Line Company scheme are

DON'T FORGET THESE 9 ADVANTAGES!


1. Open die slots for easy cleaning. No blind pockets to collect chips.
2. Enclosed die-retaining mechanism. No exposed spring to bend or break.
3. Extra heavy upright posts give greater strength.
4. Improved ratchet pawl.
5. To clean ratchet mechanism—remove four bolts.
6. Extra heavy, powerful grip screw — with convenient cross bar.
7. Patented self-contained rear-end—no bushings.
8. Grooved bolt—with hardened steel washers—for accurate centering.
9. Straight line pull in same plane as the dies.
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Patents Issued and pending.

Write for Bulletin C-1 giving full details

Buy it thru your Jobber

The NEW

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(1 to 2")

Four Poster

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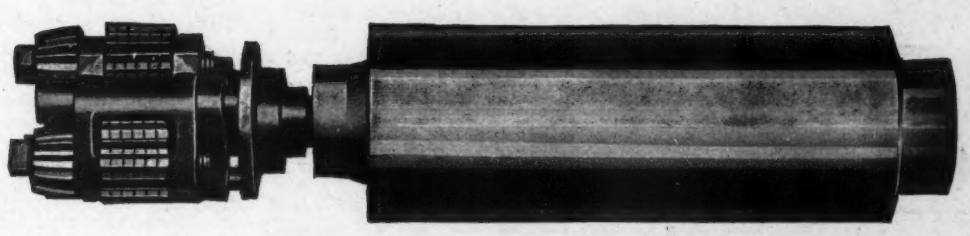
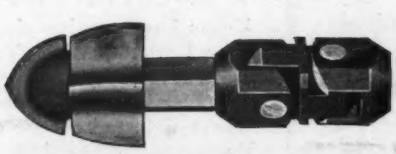
ROTO TUBE CLEANERS



Roto air-driven Cleaner for Oil Still Tubes, made in sizes for 3″ tubes and larger.



Roto Still Type Drill Head

Roto Unit Drill Head

THE ROTO CO. Sussex Avenue and Newark St., NEWARK, N. J.

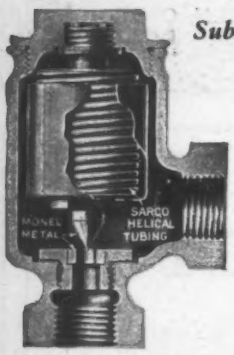
3 small plugs stop 3 times as much Leakage as 1 Large Plug

Every pocket of condensate which your steam has to pass is a point of power leakage—power you pay for but don't get.

One big trap will plug only one such leak, yet there are likely to be several pockets where condensate collects. For the *same money* you can get *three* Sarco Steam Traps, which will plug *three* leaks—keep the condensate drained from not merely one but *three strategic points.*

One Sarco, despite its small size, has as much capacity as a large trap. No supports, platforms, or pits—just screw Sarcos into the pipe line. No watching or adjusting, for each Sarco is trouble-proof and self-adjusting from 0 to 100 lbs. pressure.

More than a half million Sarcos are in service sending condensate back to hot wells while still hot, thus reducing the fuel required to re-convert it into steam.



Subject a Sarco to any test — at our expense. Mail us the coupon and we will send a Sarco for a 30-day free trial — you will be both judge and jury.

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☐ Send a Sarco Steam Trap on 30 days' free trial as follows: Size.....
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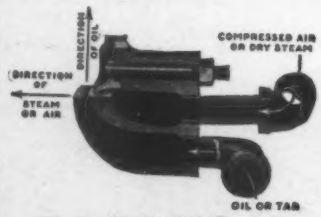
SARCO STEAM TRAP



W. N. BEST High Pressure Oil Burner

W. N. BEST Oil Burners
are
dependable, efficient, economical, non-clogging atomizers of fuel oils, tars, acid sludges and still bottoms.

Write for catalogs.

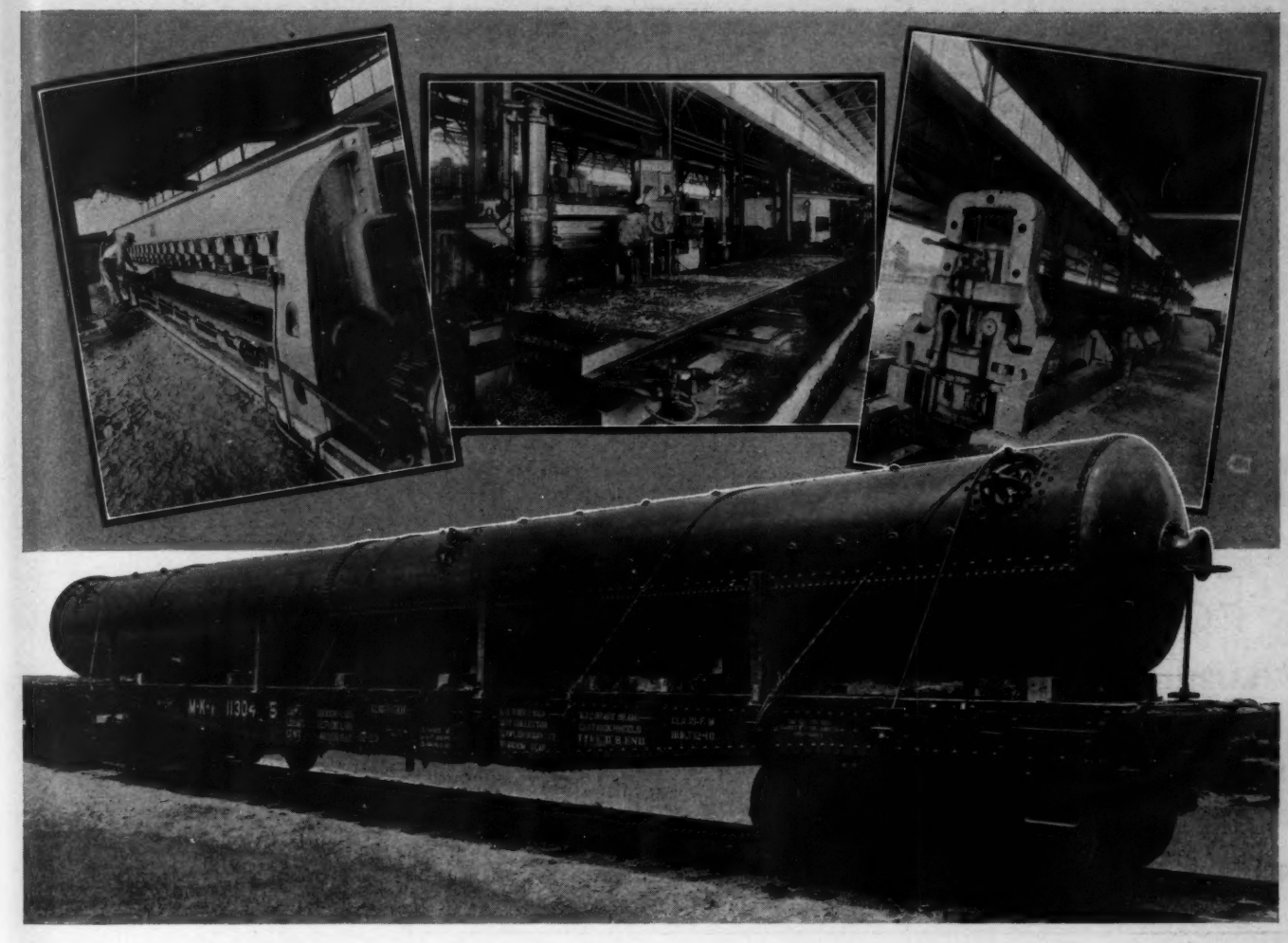
W. N. BEST CORPORATION
Engineers and Manufacturers Since 1890
295 Fifth Avenue, New York City

The Month in Review

Standard Oil Company of Ohio and Imperial Oil Company, Ltd., the latter in Canada. Rockefeller interests recently have disposed of their holdings in Prairie Oil & Gas Company and have big interests in the New Jersey and Ohio companies. Heretofore bulk of Carter Oil Company's oil has been moving south through Oklahoma Pipe Line Company's line for delivery to Standard Oil Company of Louisiana (New Jersey) at Baton Rouge.

OHIO Oil Company's acquisition of Transcontinental Oil Company was the important merger of the month passed. Consolidation was effected by splitting Ohio Oil Company stock into two new shares for one old and exchanging four-sevenths of one share of the new stock for each share of Transcontinental Oil Company. The merger follows an association which led to legal difficulties, Ohio Oil Company's subsidiary, Mid-Kansas Oil & Gas Company having joint interests with Transcontinental Oil Company in the prolific Yates pool in West Texas. Under the agreement, which it took court action to make clear, Mid-Kansas Oil & Gas Company marketed the oil produced on the joint property, whereas Transcontinental Oil Company had plans for a pipe line to a refinery proposed to be built below Houston on tidewater. By the acquisition, another of the old Standard group enters competition with others of that group in Texas. In addition to acquiring producing properties which makes Ohio Oil Company the third largest producer in Texas, important refining and marketing properties pass to its control. Refineries at Bristow and Boynton, Oklahoma, and Fort Worth, Texas, have a rated capacity of 12,500 barrels, with wholesale and retail marketing organizations to support them, give the company an important status in that field. No announcement has been made as to whether Ohio Oil Company will enter these fields under its name or retain the well established trade name of Transcontinental Oil Company and its "Marathon Motor Oil—Best in the Long Run," one of the cleverest slogans in the industry.

HOUSTON Oil Company of Texas has tentative plans for a refinery near Corpus Christi, Texas, a point favorable to such a project by reason of its port facilities and proximity to South Texas fields where the company has production. Stockholders of the company recently voted to split the $100 par shares to $25 shares and issue $2,500,000 of additional stock to provide for a stock dividend of 10 per cent on the common. Previous capital was $31,000,000 divided into 310,000 shares, of which 249,686 were outstanding. Preferred stock is $10,000,-



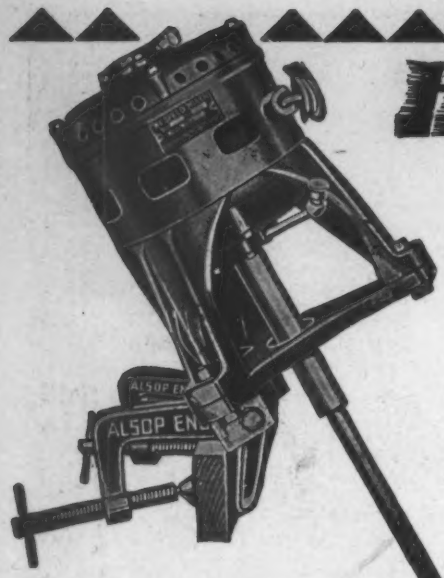
A 36-foot Cylinder With No Circumferential Seams

. . . and the machines which make it possible

The facilities of *Wyatt's* for producing Cylinders and Towers in one piece up to a maximum length of 36 feet is well illustrated above. ¶A 36-foot Plate Planer which reverses automatically bevels the plate for welding or caulking. Plate Bending Rolls 36'-6" between housings roll the plate to a true circle. A 36-foot automatic arc welder welds the joints when the cylinder is of welded construction. A 125 Ton Pneumatic Riveter drives the rivets in riveted construction after holes have been drilled by Pneumatic Drill Press shown in center. ¶*Results*—Towers of gun-barrel effect in trueness and smoothness. ¶Two large plants to serve you, One at Dallas—One at Houston.

WYATT METAL & BOILER WORKS
DALLAS *Capital $1,000,000* HOUSTON

Wyatt's **WYATT METAL & BOILER WORKS**



Hy-Speed

EXPLOSION-PROOF MIXERS

Hy-Speed Portable Electric Mixers are the most efficient machines manufactured for blending, compounding, mixing or agitating all oils and liquid chemicals.

They clamp to any tank or vat in one minute and produce a more thorough, rapid mix . . . . more economically than by any other process. Capacities from five to 50,000 gallons.

Write for your copy of «The Hy-Speed Age» ..... the Solution of your Mixing Problems.

For mixing

LUBRICATING OILS
LIME AND OIL
FULLER'S EARTH & OIL
ALL LIQUID CHEMICALS

ALSOP ENGINEERING COMPANY
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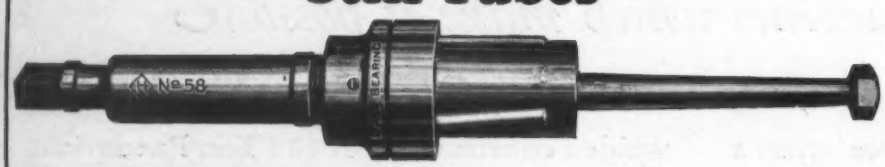
Heavy Duty Expanders for Still Tubes



Tools for the Oil Industries

Hydraulic Pressure Pumps, 8000 pounds
Tube Expanders for Cracking Still Tubes
Hydraulic Pressure Pumps, 2000 pounds
Tube Expanders for Condenser Tubes
Hydraulic Pressure Pumps, 500 pounds
Tube Expanders for Steam Boilers
Screw Punches for Structural Shapes
Tube Expanders for Pipe Work
Screw Punches for Plate Work
Flaring Tools for Still Tubes
Beading Tools for Still Tubes
Hydraulic Jacks
Hydraulic Punches

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Wilmington, Del.
Established 1870
Expanders since 1884

000—100,000 shares of which 89,476 were outstanding. Houston Pipe Line Company, a subsidiary which has a gas line serving Houston and other South Texas points with fuel from the Corpus Christi area, also increased its capital $10,000,000 to $25,000,000 to provide capital for extension and enlargements and for other corporate purposes. Houston Oil Company of Texas was organized in 1901 and for many years its activities included 800,000 acres of lands in East Texas, valuable for its timber, practically all of which has now been removed or sold to lumber companies. Republic Production Company has this property under lease. The company has important gas produciton in South Texas to supply its gas line subsidiary, and also has some production and a refinery in Arkansas.

HYDROGENATION process has been made available to Royal Dutch Shell through agreement between those interests and I. G. Farbenindustrie and Standard Oil Company of New Jersey. The agreement was announced by Sir Henri Deterding following release of the annual report of the Royal Dutch Shell group at Amsterdam. Following the announcement, Standard Oil Company of New Jersey issued a statement to the effect that Shell's participation in hydrogenation does not include patent rights in the United States. It was said that under the plan it is proposed that licensing of the process will be carried out in foreign countries under the same plan that is now being worked out in the United States. The several parties licensed throughout the world, including chemical industries not interested in application of the process to petroleum, will pool the results of their research and experience in application of the process and each will have the right to use improvements.

Hydrogenation plants under construction in the United States include: Standard Oil Company of New Jersey, Bayonne; Humble Oil & Refining Company, Baytown, and Standard Oil Company of Louisiana, Baton Rouge; the two latter companies are subsidiaries of the New Jersey Company. Additional installations are reported as planned by Imperial Oil Company, Ltd., Toronto, Canada, (Standard Oil Company of New Jersey in Canada); Magnolia Petroleum Company, Beaumont; Grayburg Oil Company, San Antonio.

BARNSDALL Corporation, according to announcement of E. B. Reeser, its president, will show earnings of 90 cents per share for the second quarter of 1930 as against 99 cents for the same period in 1929. This means, on 2,247,658 shares outstanding, that earning will be approximately $2,023,000, compared with $2,226,881 last year. For the first quarter the company reported earnings of 63 cents a share, bringing the total for the first half to $1.53 per share, compared with $1.83 in 1929, or a net profit for the first six months of 1930 of $3,428,595, as against $4,115,253 for the same six months in 1929.

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GRADY TRIPLETT, *Editor* GEORGE REID, *Associate Editor*

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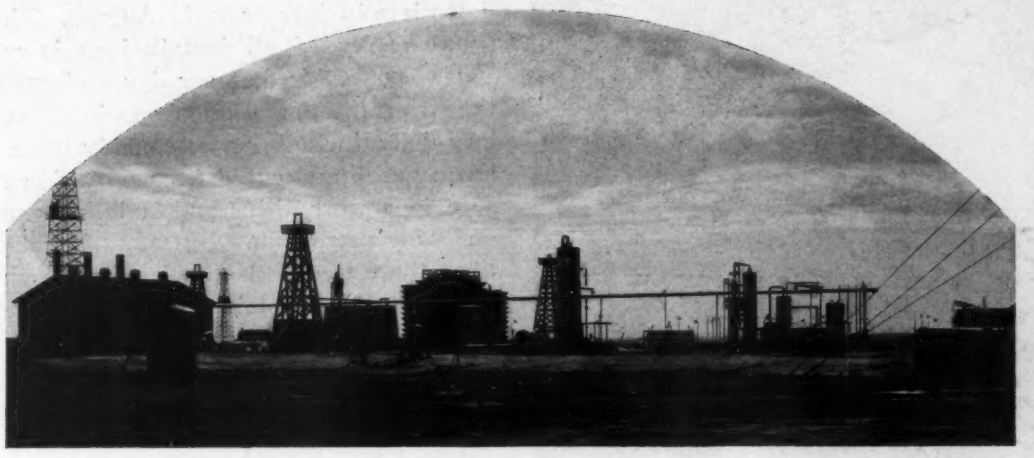


Gasoline Plant Methods At Oklahoma City

By GEORGE REID
Associate Editor

GASOLINE plant practice in the Oklahoma City field where 14 installations of relatively high gas capacity are operating or building at this time, does not differ markedly in general principle from absorption plant practice in other high pressure fields. Problems of operation consist chiefly of processing a lean gas at 30 to 40 pounds pressure, compressing the residue to pressure requirements of field fuel lines, gas lift lines and gas mains leaving the field. Rock pressure in the field is around 2000 pounds, which condition eliminates the use of compressors prior to absorption but requires additional pressure reducing or regulator equipment. Most of the gasoline produced must be chemically treated for the reason that it is slightly sour to the Doctor test.

Under proration operaion in the field whereby wells are held within 16 2-3 per cent of estimated potential output, natural gasoline plant operation is influenced to the extent that balanced efficient operation has been practically impossible of attainment. With few wells connected to each gasoline plant, any change in the gas flow from any well disturbed the operation of the plant. With the increased development of the field this condition is righting itself to some extent because of more wells connected to each plant, but the influence of proration operation of the field still constitutes a problem in gasoline plant operation.

Because of the scheme of proration of oil production in this field and because the gas is "lean" and because all other factors point to large scale operations being essential to attain profitable results, there has been no actual rush to construct plants in this territory. While gasoline content of the gas

varies somewhat with the method of producing the individual well, the reports of various companies indicate that gas reaching the plants carries from 200 to 500 gallons of gasoline per million cubic feet of gas. This compares with the gas production in North-Central Louisiana. There are further indications that some of the practices of the Louisiana operators might well be adopted by the Oklahoma City plants, chief of which is operation of absorption equipment at somewhat higher pressures than is now prevalent.

At the time of this writing three of the 14 gasoline plants in this field are building, with completion dates late in July or early August. The total rated gas capacity of all installations is approximately 700,000,000 cubic feet per day and gasoline production from the operating plants is about 250,000 gallons daily, including a reasonably large gallonage of rerun gasoline secured from operation of high pressure separators, drips and stabilizing units working on crude petroleum. By way of analysis of conditions there were 281 completed producing wells late in June and a total of 369 operations in various stages of rigging up and drilling, which gives a total of 650 operations. It is estimated that the field will involve the drilling of at least a thousand wells, based on geological contour maps.

With such probable future development seemingly necessary and with the present inability of the operating gasoline plants to handle much more gas than their rated capacity, and with natural gas production far in excess of gasoline plant capacity, it is certain that further installations of gasoline extraction equipment will be necessary. For this reason most of the plants now operating have been designed to allow future expansion without serious interruption of operaion of present equipment. This expansion will of course be governed by the continuance of proration agreements in the field. Many of the plants in the field are at this time adding additional compressor equipment for returning residue to the various distributing agencies and additional available gas in being processed through the absorber facilities.

METHODS OF EXTRACTION

General plant practice in the field calls for the extraction of gasoline at absorber pressures averaging 30 to 40 pounds, although one plant is absorbing at 90 pounds pressure, which practically doubles the volume of gas treated through the equipment and

Illustrations on this page show Indian Territory Illuminating Oil Company installations at Oklahoma City. Above is interior of compressor plant at the Trosper Park plant operated jointly with the Franklin interests. In the center is cooling and condenser water equipment at the Farley lease plant. Below is the Jones plant in the south end of the field, under construction.

secures a corresponding increase in gasoline produced. After reduction from field pressures at the well ranging upward to 2000 pounds, and after absorbing at these low pressures, the residue gas is then recompressed to meet the demands of distributing agencies. The field fuel lines, for example, are operated at 125 to 175 pounds pressure. Gas companies purchasing gas in the field operate their lines at 350 pounds and gas lift requirements call for gas at 300 to 350 pounds pressure. This latter use will increase in importance as the field becomes older and the natural pressure declines. At present 14 wells are operating on the gas lift, and the extended use of this system will influence the number of compression units to be employed in this field. For the most part this type of equipment is being purchased and installed as new machinery instead of transporting the compression equipment at Seminole over to the Oklahoma City field as was once deemed advisable.

This system of operation, however, is not an economic practice and the high pressure absorber of the type employed in Louisiana and California in high pressure work will no doubt find its way into the Oklahoma City area unless the field indicates an abrupt lowering of rock pressure as exploitation of the producing area progresses.

Due to the high rock pressure it is thought that much of the curde is charged with light fractions which should be present in the natural gas for the reason that these fractions have become absorbed in the oil. In two plants the crude is stabilized through application of gasoline plant equipment to such work. At the Button plant of Indian Territory Illuminating Oil Company and the Stamper plant of Sinclair Oil & Gas Company such units are installed.

These units are called "rerun" plants. At the plant of the Indian Territory Illuminating Oil Company the so-called wild or rich crude produced in parts of the field is stabilized through the removal of sufficient light fractions to reduce the gravity from 46° to 52° A. P. I. down to 38° to 40° A. P. I. This unit and the similar installation at the Sinclair Oil & Gas Company plant also fractionates the drip gasoline accumulating in substantial quantities in the field. There is a large quantity of drip gasoline fractionated at the plant of Amerada Petroleum Corporation, but none of the so-called "wild" crude is processed at this plant.

The crude stabilizing unit on the Button lease consists essentially of exchangers, two combination Tulsa Type steam heated absorption-fractionating columns, coolers and a continuous treating unit. The high gravity crude or drip is segregated in five

Company, Lease—	Absorbing Units	Distillation Units	Fractionating Units	Compressor Units	Rated Capacity[1] in Millions of Cubic Feet
Amerada Petroleum Corporation, Kinter	1	1	1	Well pressure	40
Coline Oil Company, Olds	2	2	1	9	75
Cromwell-Franklin-Indian Territory Illuminating Oil Corporation, Trosper	2	1	1	15	50
Wirt Franklin Petroleum Corporation, Lowery	2	1	1	4	40
Indian Territory Illuminating Oil Company, Bodine	2	1	1	19	50
Indian Territory Illuminating Oil Company, Vern	2	1	..	16	50
Indian Territory Illuminating Oil Company, Button	2	1	..	15	50
Indian Territory Illuminating Oil Company, Farley	2	1	..	6	50
Indian Territory Illumiating Oil Company, Jones	2	1	..	20	50
Phillips Petroleum Company, Sigmon	4	2	1	31	60
Shell Petroleum Corporation, Petty	2	1	1	..	15
Sinclair Oil & Gas Company, Stamper	4	2	..	4	100
PLANTS BUILDING					
Phillips Petroleum Company, Jones	4	2	..	..	60
Indian Territory Illuminating Oil Company, Lemon	Compression plant			18	

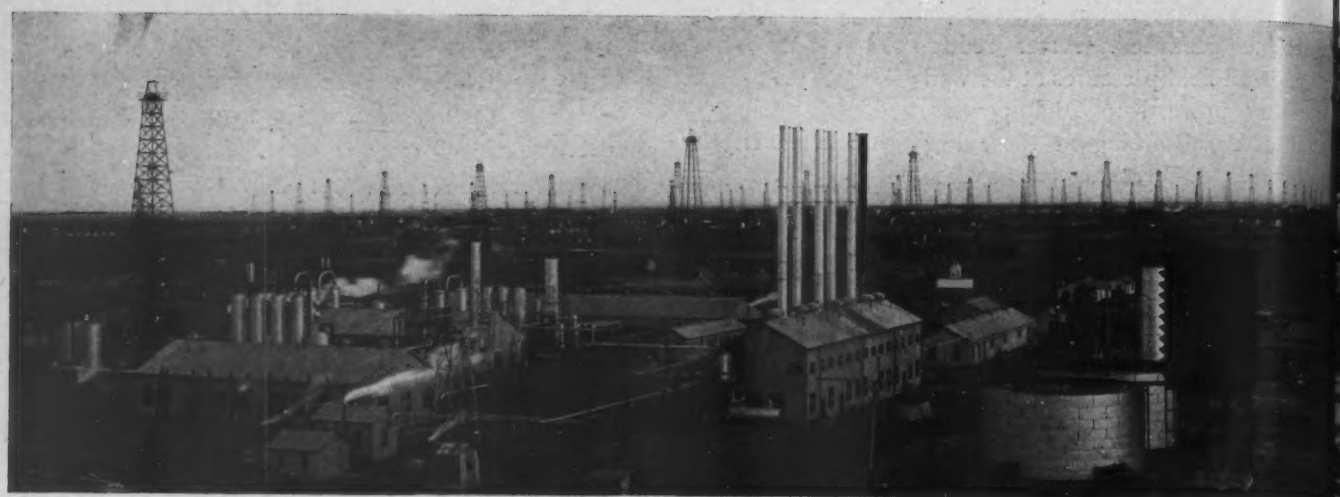
[1] Figures in this column are for rated capacities No plant in the Oklahoma City pool is operating at its rated capacity.

NATURAL GASOLINE PLANTS IN THE OKLAHOMA CITY FIELD

Companies operating gasoline plants, rated capacity in cubic feet per day and approximate production of natural gasoline daily, as of June 30.

	Type	Rated Gas Capacity—Cubit Feet	Approximate Gasoline Production—Gallons
Amerada Petroleum Corporation—* Kintner Lease, Section 30-11-2w	Abs.	40,000,000	20,000
Coline Gasoline Corporation— Olds Lease, Section 24-11-3w	Abs.	75,000,000	20,000
Franklin, Wirt— Lowry Lease, Section 12-11-3w	Abs.	40,000,000	13,000
Indian Territory Illuminating Oil Company— Bodine Lease, Section 24-11-3w	Abs. Comp.	50,000,000	15,000
Indian Territory Illuminating Oil Company—* Button Lease, Section 19-11-2w	Abs. Comp.	50,000,000	50,000
Indian Territory Illuminating Oil Company— Verne Lease, Section 13-11-3w	Abs. Comp.	50,000,000	15,000
Indian Territory Illuminating Oil Company— Sudick Lease, Section 31-11-2w	Comp.	10,000,000	Bldg.
Indian Territory Illuminating Oil Company— Trosper Lease, Section 11-11-3w	Comp.	10,000,000	Bldg.
Indian Territory Illuminating Oil Company & Cromwell, Franklin— Farley Lease, Section 19-11-2w	Abs. Comp.	50,000,000	15,000
Indian Territory Illuminating Oil Company & Cromwell, Franklin— Trosper Lease, Section 12-11-3w	Abs. Comp.	50,000,000	15,000
Phillips Petroleum Company— Sigmon Lease, Section 32-11-2w	Abs.	60,000,000	20,000
Phillips Petroleum Company— Floral Hill, Section 1-11-3w	Abs.	60,000,000	Bldg.
Shell Petroleum Corporation— Petty Lease, Section 30-11-2w	Abs.	15,000,000	15,000
Sinclair Oil & Gas Company—* Stamper Lease, Section 30-11-2w	Abs.	100,000,000	65,000

* Plants rerunning drip or stabilizing crude.



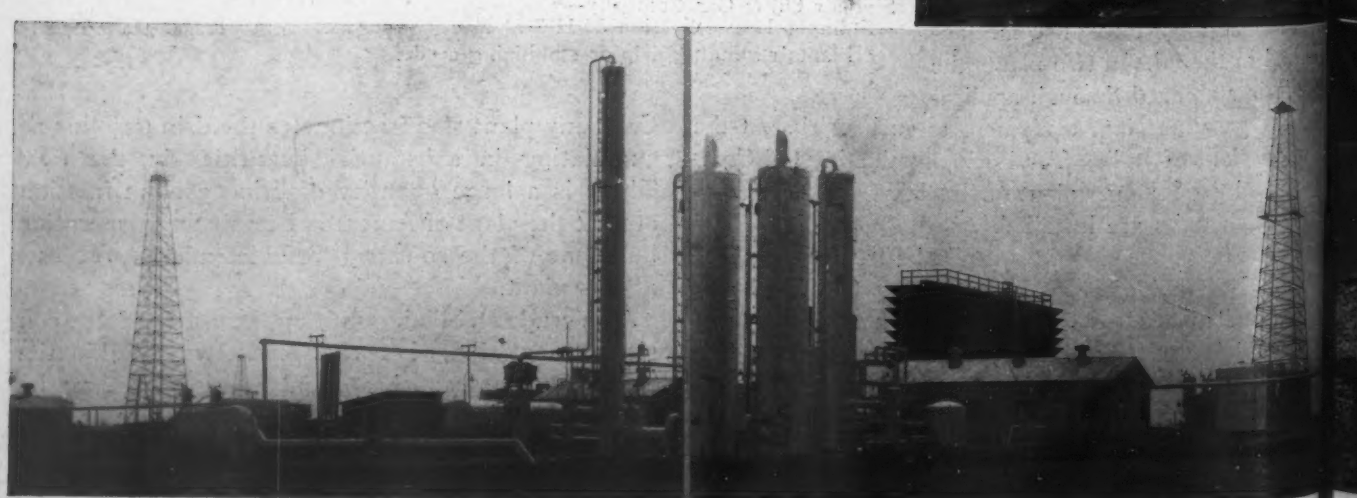
Above: Sinclair Oil & Gas Company's Stamper Lease Plant.

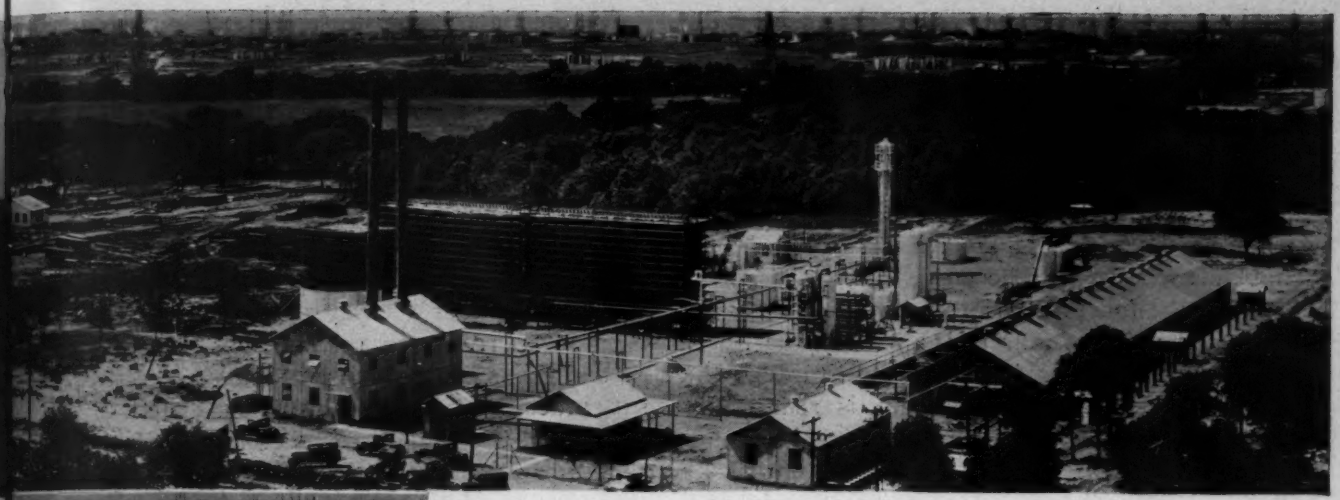
Right: Coline Gasoline Corporation's Absorption and Gas Compression Plant, Olds Lease.

Representative

Natural Gasoline Plants

Below: Wirt Franklin Petroleum Corporation's Lowery Lease Plant





Indian Territory Illuminating Oil Company-Cromwell-Franklin Trosper Park Plant

Operating in

The Oklahoma City Field

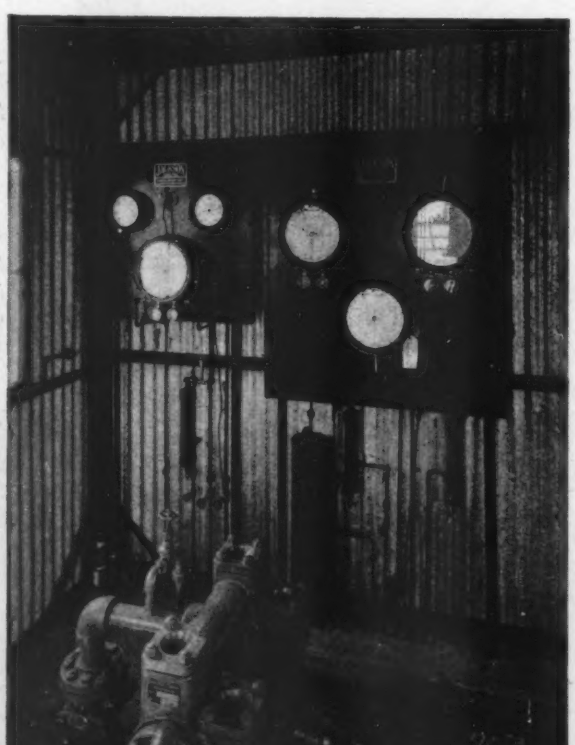
Left: Indian Territory Illuminating Oil Company's No. 3 Button Lease Plant.

Below: Outdoor motor-driven centrifugal pumps, Indian Territory Illuminating Oil Company's Farley Lease Plant.

10,000-barrel tanks near the plant. From here the cold crude is handled by a motor-driven centrifugal pump and passed through six Tulsa Type exchangers. From this point the crude passes through three steam heated preheaters, where it is raised in temperature to 360°F. The heated crude stream is split and conducted to two 7 x 35-foot absorbers, which are used as stills and which are provided with 10 bubble trays each. The crude enters the absorbers above the fourth tray and the remaining liquid portion of the charge falls to the base of the tower to be removed under liquid level control through the exchangers, where the temperature is reduced to about 150°F. The crude is further cooled through six Griscom Russell sections set in a Fluor water cooling tower, and removed to storage, stabilized. Bundles of steam heater coils are placed in the bottom of the tower-stills, and maintain a still temperature of about 360°F.

Gasoline vapors leaving the tops of the two distillation units are combined into a common header and are condensed as they pass through 18 Griscom Russell sections in the same cooling tower. The gasoline is stored in a 10,000 gallon surge tank which is equipped with float control to regulate the volume of gasoline going to the continuous treating plant, with the control governing the operation of the pump discharing to the treating unit. This pump also functions to recycle reflux material over the tops of the two fractionating columns by means of a small take-off line provided for this purpose. After sweetening through the use of sodium hypochloride solution, the gasoline is run to finished storage. The finished gasoline has an initial boiling point of 94°F.; five per cent at 124°F.; 350 end point and 96 per cent or better recovery.

This type of unit effects a stabilization of the higher gravity crudes and greatly reduces the storage losses in the lighter grades. In addition it reduces the gravity to that of the general average of production in the field so that it falls within the price range of 40 gravity crude. Also these units are of importance in processing the substantial quantities of the amber colored drip gasoline accumulating in the traps because of the high rock pressures in the field. This material yields about 92 per cent gasoline of 375 end point with less than eight per cent residue.



Control room at the Wirt Franklin Petroleum Company natural gasoline plant.

Another innovation in this field is the use of batteries of high pressure separators, which system is designed to take advantage of the existing high pressure to reduce the volume of gas treated in the gasoline plants. Indian Territory Illuminating Oil Company has four batteries of this type in service in the field. Four high pressure and one low pressure separators are used in this system to handle the production from four wells with the crude oil and gas entering the four separators working in parallel at 300 pounds pressure. In this step the separation of oil and gas is effected at 300 pounds and at this pressure practically all of the gasoline is held in the crude as a liquid and the gas removed from this high pressure separation is practically dry. As such it is returned to the field fuel lines or to gas lines for outside distribution.

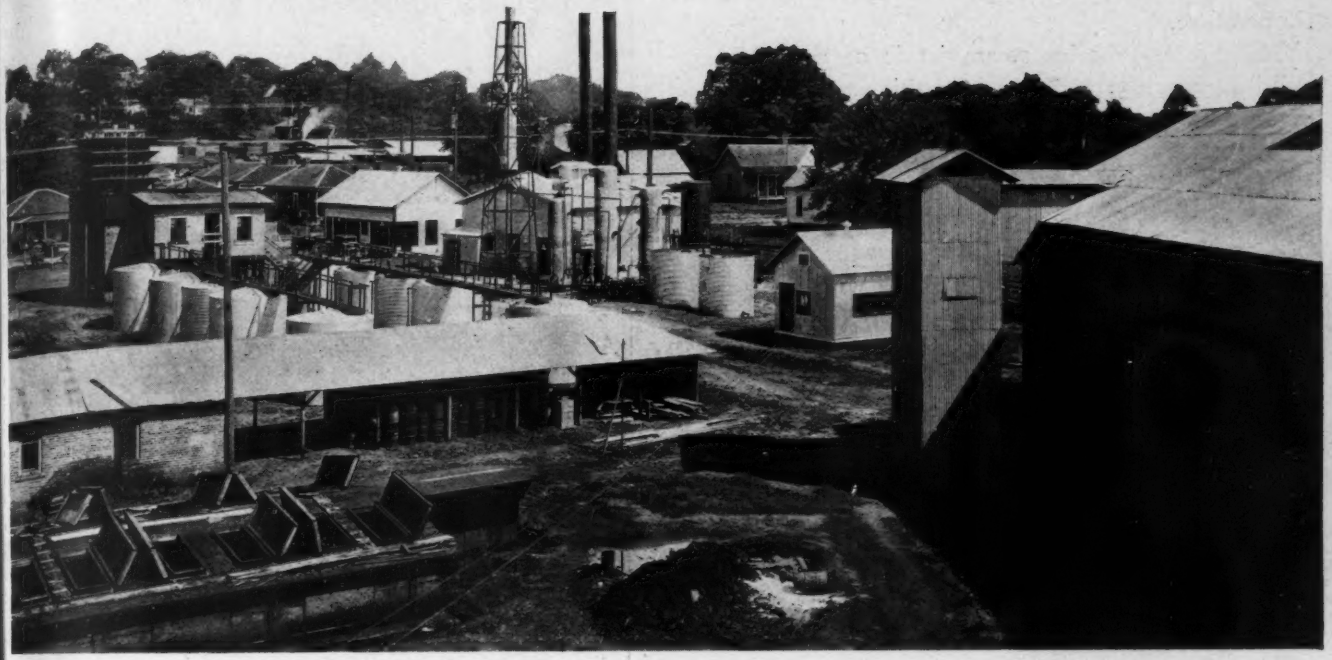
From the high pressure separators the crude is passed into the low pressure trap where the reduction in pressure and accompanying expansion effects an evaporation of the more volatile or lighter fractions and carry with them a portion of the less volatile fractions. This material is accumulated and taken to the gasoline plant for redistillation. This practice effects the removal of the more volatile portion of the light crude while it is fresh and before it goes to any type of field storage. Thus storage losses are greatly reduced and the excellent grade of light gasoline is saved.

PLANT METHODS

Gasoline plant lay-out at practically all of the 14 installations follow the prevailing rectangular style of placing equipment with occasional variation occurring due to condition or dimensions of plant sites. Practically all of the plants in this field consist of new equipment insofar as compressors, absorbers, distillation, exchanger, preheater, and power house equipment is concerned. One exception is noted in Amerada Petroleum Corporation's plant in Section 33-11-2w, which is comprised of one of the earliest Tulsa type absorption systems and other facilities moved to Oklahoma City by this company from plants located in the Keeley and Tonkawa territories. The tendency is strictly toward the use of modern materials of late design placed in operation under full automatic control and with great care given to safety features.

(*Continued on page 147*)

By NEIL F. BLAINE



View of the Nacogdoches Refinery, Inc., plant at Nacogdoches, Texas.

Nacogdoches Refinery Uses Combination Process

WHEN Nacogdoches Refinery, Inc., purchased the old type refinery at Nacogdoches, Texas, it consisted of conventional old-style shell still, with dutch oven furnaces and condenser equipment. It had no fractionating columns, dephlegmators or equipment of that nature. The new owners removed all of the old distilling equipment and installed a single flash vacuum distilling unit in its place.

There are several unusual features about this process. In the first place, the crude oil runs about 50 per cent finished lube, the top fraction being gas oil. The plan was designed to handle 1500 barrels per day and be capable of overloading to 200 per cent rating.

Briefly, the process consists of heating the oil by means of heat exchangers recovering waste heat, and retort, bringing it up to the proper temperature, atomizing it by the use of superheated steam into a flash chamber where all the oil is vaporized with the exception of the asphalt, which is drawn off. The vapors pass through fractionating towers from which successive cuts are drawn off. The gas oil and steam are finally separated in a stripping section and the steam condensed. This is all done under 26 to 28 inches of vacuum throughout.

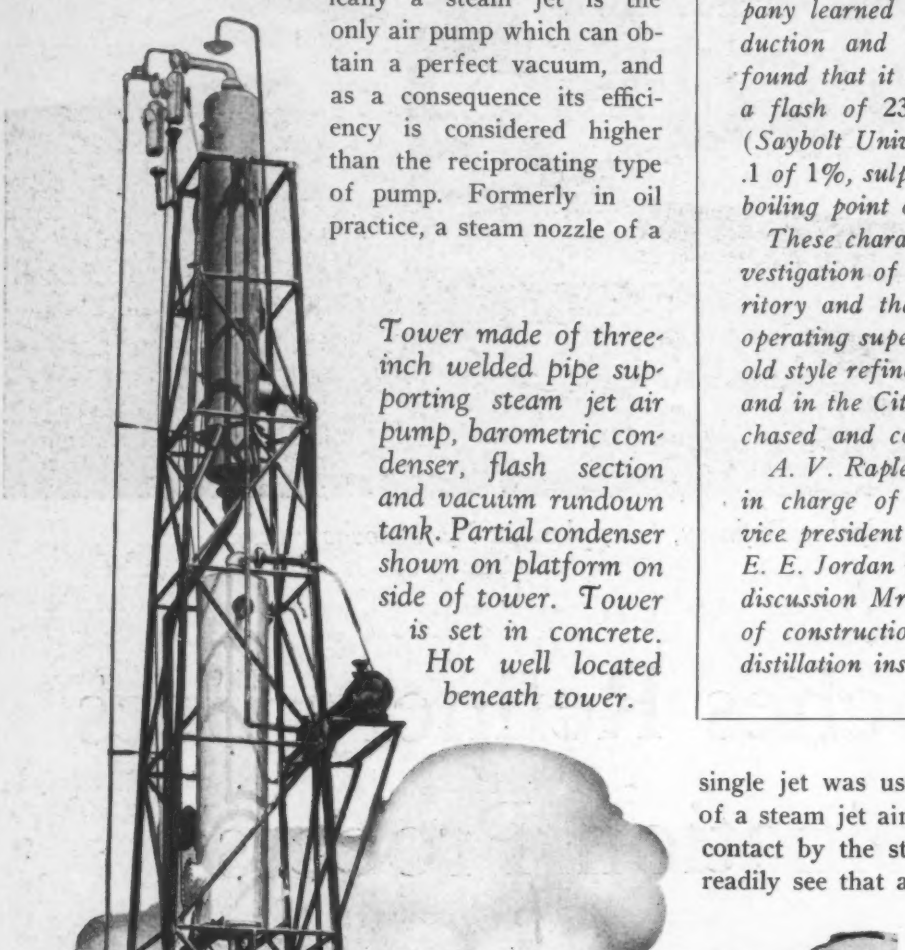
The equipment used is a Foster-Wheeler superheater, two 125 horsepower HRT boilers, Boner-Sheldon towers, Southwestern and Braun heat exchangers, Foster-Wheeler steam jet and barometric condenser. For control of the products drawn off, a Brown pyrometer, Brown steam flow meter, National oil meter, Foxboro recorder-controllers, and conventional pressure and vacuum gauges are used.

The retort for heating the oil is unique in design, there being only a short passage of oil through tubing in the heating area. Due to the fact that there is obtained through heat exchange with streams drawn off theoretically 410°F., in plant operation 375°F., the oil at that temperature is hardly viscous, and consequently will easily pass through tubes 2½ inches in diameter under pressure, and will obtain sufficient heat to flash into vapors upon entrance into the reaction chamber.

Steam is introduced into the system at the temperature of the oil vapors at the point of introduction. This is for the purpose of increasing the sum of the partial

pressures so that the vapor pressure of the oil-steam phase can overcome the pressure in the reaction chamber and towers and consequently vaporize at a lower temperature.

The Foster-Wheeler steam jet is of the two-stage multi-jet nozzle type. The reason this particular method of obtaining a vacuum was selected is because theoretically a steam jet is the only air pump which can obtain a perfect vacuum, and as a consequence its efficiency is considered higher than the reciprocating type of pump. Formerly in oil practice, a steam nozzle of a single jet was used, but inasmuch as the air capacity of a steam jet air pump is dependent upon the surface contact by the steam and air or fixed gases, one can readily see that a multi-jet nozzle is much superior to a single jet nozzle, and as a consequence is more economical because of a greater area of contact per unit volume of steam. Further, a two-stage steam jet was selected to avoid pulsation found in vacuum systems when a single-stage is used.



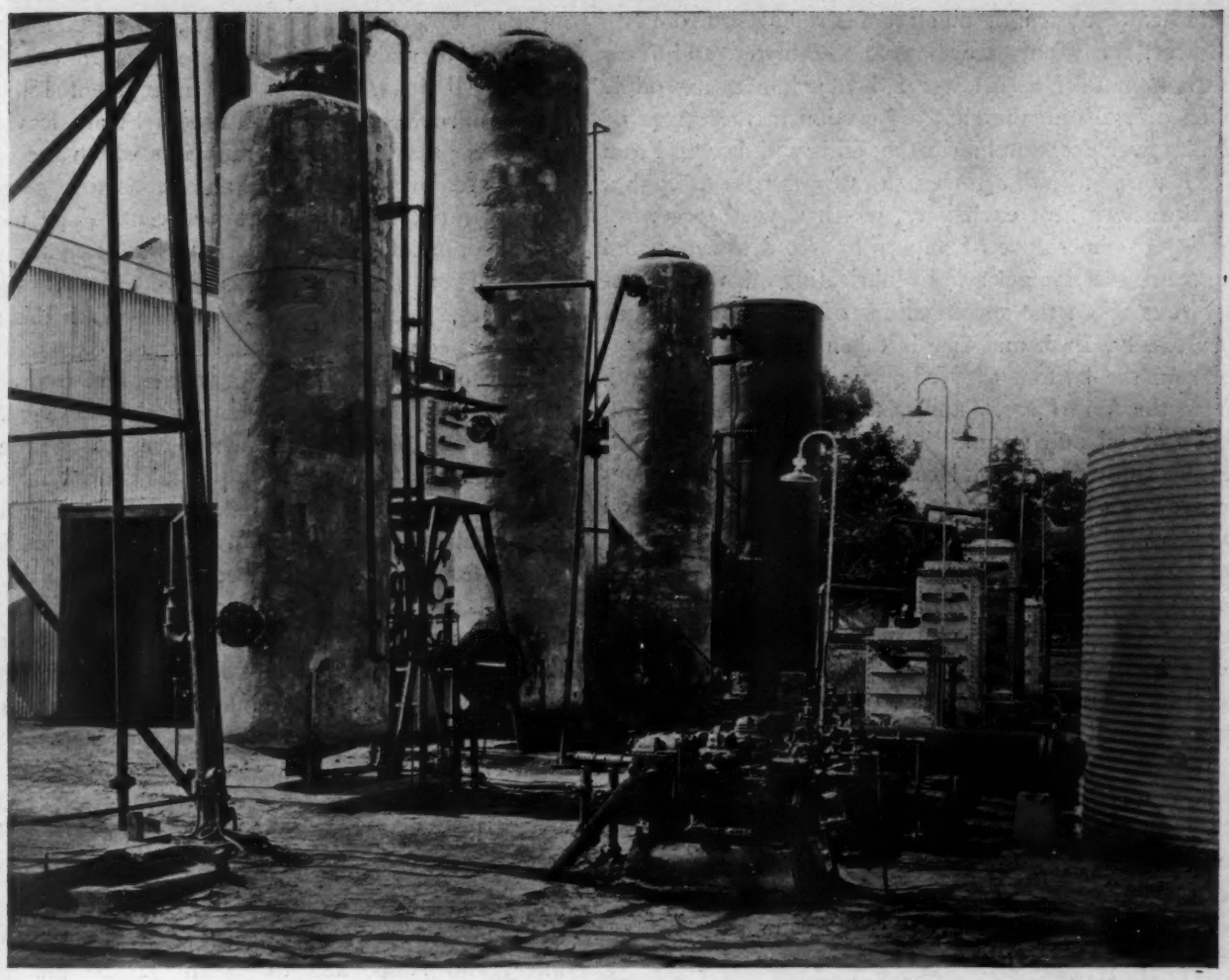
Tower made of three-inch welded pipe supporting steam jet air pump, barometric condenser, flash section and vacuum rundown tank. Partial condenser shown on platform on side of tower. Tower is set in concrete. Hot well located beneath tower.

This is used in conjunction with a Byer type barometric condenser, and together as a unit no difficulty has been experienced in obtaining 28 inches of vacuum as referred to a 30-inch column of mercury, and at the same time condense 1500 pounds of steam per hour, and handle fixed gas and non-condensibles up to 20 or 25 cubic feet per minute. We circulate 69[illegible] gallons per minute of 70°F. cooling water through the barometric condenser while plant is in operation.

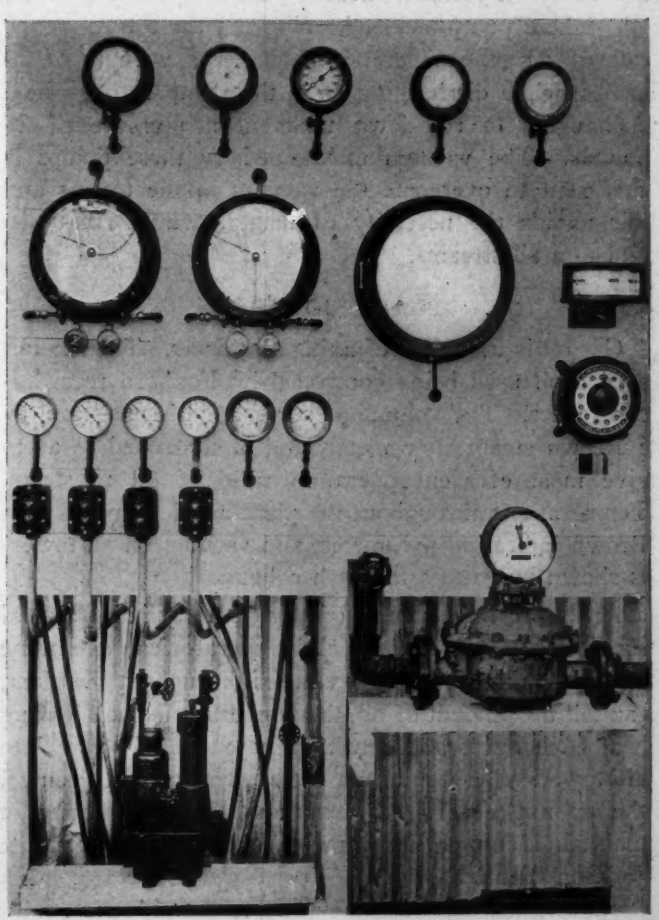
NACOGDOCHES Refinery, Inc., is a subsidiary of Bloomfield Oil Refinery, Inc., of Nevada, and is operating the refinery recently constructed at Nacogdoches, Texas, utilizing a combination steam and vacuum process. Through associates in California the company learned of the Nacogdoches shallow production and upon examination of the crude found that it showed a gravity of 21.2° A.P.I., a flash of 235°F., viscosity of 400 at 100°F. (Saybolt Universal); pour test of 0°F., BS&W .1 of 1%, sulphur .31 of 1%, and with an initial boiling point of 375 F.

These characteristics warranted a thorough investigation of the refining possibilities in this territory and the company sent its engineers and operating superintendent to study conditions. An old style refinery was found adjacent to the field and in the City of Nacogdoches which was purchased and completely rebuilt and modernized.

A. V. Raplee is president of the company and in charge of construction. Neil F. Blaine is vice president and in charge of plant operation. E. E. Jordan is treasurer. In the accompanying discussion Mr. Blaine has presented the details of construction and operation of this vacuum distillation installation.



Details of bubble towers and reaction chamber. Uninsulated tower is flash chamber Below: Control panel from which operation of plant is observed and largely controlled



It is of interest to note that there is an artesian well on the plant which flows at the rate of 125 gallons per minute. This is picked up by a pump which can handle 125 gallons per minute and discharge through the cooling tower to storage reservoir. The water comes out of the well at a temperature of 76°F. It shows absolutely soft as shown by alkalinity method of testing. Soap test is used for routine control.

The process might be termed as a combination steam and vacuum process. The vacuum is employed to lower the pressure in the stills below atmospheric pressure so that distilling temperature of the oil will be lowered beyond the possibility of any undesirable cracking taking place in the flash chamber. Steam is used to control the velocity in the towers, as well as the work being done in connection with partial pressures.

PROCESS STEPS

Lubricating oil streams are taken off in the following manner: After the asphalt has separated in the flash or expansion chamber, the rest of the oil in vapor form, which is about 90 per cent, travels overhead into No. 1 tower. From the bottom of No. 1 tower, an

extra heavy lubricating oil stream is removed. From No. 1 tower, the vapors travel to No. 2 tower, and from the bottom of No. 2 tower a heavy lubricating oil is taken off. From the shut-off section in the center of No. 2 tower, medium lubricating oil is withdrawn. From No. 2 tower to No. 3 tower, the vapors pass through a Southwestern heat exchanger, which is used to control the inlet temperature of vapors to No. 3 tower. From the control exchanger a light lubricating oil, which usually runs about the specifications of transformer oil as to viscosity, flash and fire is taken off.

From the bottom of No. 3 tower comes Diesel oil. From the top of No. 3 tower the vapor phase is composed of oil and steam. These vapors go to a flash section through a special condenser. The partial condenser cools the vapors to such a point that the gas oil is separated off as a liquid, then the liquid and the steam are separated in the flash section, the gas oil being drawn off the bottom to a vacuum run-down tank and the steam going overhead to a barometric condenser, where it is condensed. The flash section prevents mechanical entrainment of gas oil in the steam going to the barometric condenser.

Inasmuch as all operations from the point of flash to final condensation of the steam have been done under a vacuum, running from 28½ inches at the barometric condenser to 22 inches at the point of flash in the flash or expansion chamber, it follows that no streams could be taken off the towers unless the vacuum in the towers was overcome. This is done on this plant by the use of Byron-Jackson vacuum pumps, operating on hot oil. These pumps will take oil from the towers at the rate of 30 gallons per minute under a vacuum of 20 inches, while discharging from the pump through heat exchangers to run-down tanks at a pressure of 25 pounds. The vacuum maintained by these pumps is sufficient to overcome the vacuum in the towers and this avoids the necessity of using vacuum run-down tanks on all streams.

PLANT CONTROL

Gas oil is used for refluxing all towers. The amount of gas oil used being controlled by Foxboro recorder-controllers. The volume of steam used is measured by a Brown steam flow meter, and is controlled so as to give most efficient operation ratio of oil to steam. Temperatures throughout the plant are determined by a Brown indicating pyrometer, and vacuum on all towers is shown by gauges for each column.

An interesting feature of this refinery is its central control panel. At this panel the operator can determine all his temperatures and pressures throughout the plant, can tell the amount of oil, the temperature of oil leaving heat exchangers and retort, the amount of steam into his towers, the vacuum on each tower, and can control the amount of reflux to towers and amount of vacuum maintained on each stream taken off by the Byron Jackson vacuum pumps.

In conjunction with the towers, natural gas equipment liquid level controls and Wilgus regulating valves are used to maintain constant levels. In conjunction with the boilers, Natural Gas Equipment 150 horsepower burners, type A, are used. Steam leaving the boilers is passed through Tracyfiers which are guaranteed to remove all moisture and solids to a content of less than two-tenths of one per cent. The moisture and solids from the Tracyfiers pass to Nicholson steam traps. From there it is discharged automatically into the sewer. No attempt is made to reclaim this water, due to its content of solids and impurities.

The burner under the superheater and retort is one designed and built in the plant fabricating shop. The primary function of this burner was to operate on a gas pressure of three to five pounds and obtain a great amount of primary air so that combustion would be completed close to the burner and no flames would ever reach the tubes. This was necessary because the retort is small, and is packed with tubing for heating steam as well as oil. We have found this burner very satisfactory in every respect, and no flames reach the tubes. The hot gases are baffled by means of arches from one bank of tubes to another in such a manner that final stack temperature will run below 600°F.

Hot streams are taken from the towers by means of Byron-Jackson vacuum pumps and are discharged from the pumps through heat exchangers to rundown tanks.

Auxiliary equipment built for use in connection with the plant includes a tower designed and built at the refinery, for supporting the steam jet air pump, barometric condenser, flash section, vacuum run-down tank and partial condenser. Beneath this tower is located the hot well, where the condensed steam and water are taken from the barometric condenser and pumped to a cooling tower, which also was designed and built at the plant by company engineers.

There are certain features about the process which are not yet ready to disclose, because of patents pending, but it will suffice to say that by the use of a catalyst as an aid to vapor-phase treating in the unit operators are able to take off a finished green bloom lubricating oil directly, and eliminate the use of acid, clay, caustic soda, or other chemical treating methods. Inasmuch as the crude itself is inherently of a high quality and wax-free, we are enabled to produce finished oils of a uniformly high degree of oiliness as will be noted by the comparative viscosities at 100°F. and at 210°F. in the accompanying specifications.

	Medium	Heavy	X Heavy
Gravity	21.5	20.5	19.5
Flash	390	405	415
Fire	440	460	480
Vis. @ 100°F.	350	550	750
Vis. @ 210°F.	75 sec.	77 sec.	80 sec.
Pour test	0°F.	5°F.	10°F.
Color	Green Bloom	Gr. Bl.	Gr. Bl.
Carbon Residue	.03%	.05%	.10%
Acid (Mg of KOH)	.05%	.05%	.05%
Sulphur	.03%	.07%	.07%

Sales are handled by Hy-Test Petroleum Products, Inc., with general offices in Los Angeles, California, and Nacogdoches, Texas.

EDITORIALS

ONE just criticism of the refining industry is its failure to keep its regulatory measures active long enough to bring desirable results.

Early this year the Sunday shut-down came along as a remedy for the over-supply of gasoline. It ran its course in a few weeks and was abandoned, with announcement to the effect there was no longer need for the measure.

Now there is a movement to curtail refinery runs on a percentage basis. While there seems to be no uniformity as to the percentage of still run reduction, there are sufficient instances of its adoption to warrant the conclusion that many refiners realize there is necessity for making less gasoline.

The inconsistency comes in the fact that the Sunday shut-down was discarded as no longer required; while the percentage reduction comes along so shortly afterward that it stamps the refining industry as not knowing what it needs in the way of curtailment. If abandonment of the Sunday shut-down was justified in the spring, curtailment is hardly in place now. If curtailment is needed now, there was need for the Sunday shut-down to have continued.

Methods are beside the point. It makes no difference how gasoline stocks are reduced, so far as the industry is concerned.

But this abandonment of one only to adopt another speaks in favor of some method that will last. No industry is going to better its position and neither will any company better its position by frequent changing of curtailment of methods.

FEW workmen harbor any objections to safety measures. The few who do oppose efforts to prevent injury and save life, should be removed from contact with other workmen. They warrant no place in industry.

But there are many who, without objection to safety, do oppose regulations which are set up without consideration of the workmen. Some will question the use of goggles if told to wear them through a printed order from an office.

Given a chance to determine for themselves that goggles or any other sensible procedure is good, workmen immediately become enthusiastic for the device or regulation. This gets back to psychology, which is something management must consider, whether it likes mental reactions or not. The human mind is geared to work that way.

The best set of safety regulations any working force can have is the set it selects for itself. It is necessary that there be direction in bringing men to make such selections but that is the function of management.

RECENTLY a clothing salesman had a long distance request to call on a small town merchant just as soon as possible. The salesman had visited the merchant that week and gone away without a sale. Inquiry revealed that a pipe line construction crew had just moved into the area and bought out all the work clothes in town.

The salesman burned some gasoline that day and sent an order by telegraph which his house filled and sent by express.

This is a trivial incident in the business world but it represents the process by which business will find its way back to bigger volume.

The centering of that pipe line crew near one small town can be expanded into the consumption of much merchandise. The salesman bought an extra tank full of gasoline that day. The telegraph company carried another message. The wholesale house bared a few shelves and made room for merchandise which will require a few hours of the time of a manufacturing concern. All those involved in the labor of these activities will spend the money of their labor for food, clothing, gasoline and amusement.

It all gets around to the refiner on this basis. American business is not up to the volume of last year or the year before. To reach a desired figure in volume, business must work back slowly. What happens in the building of a pipe line or the making of work clothes reaches into the whole blood stream of commerce to add vigor to production.

There seems to be too much of expecting business to get better. Business is not going to get better by any sudden quickening of the pulse of commerce. Business must work out slowly, just as it went into depression slowly.

Just as months were required to bring the level of trading down, months will be required to bring the trade level upward. In that period it is foolhardy to expect volume in any commodity to match the volume of 1928 or 1929.

To the refiner it means that less gasoline will be used, just as less of other commodities may be used. He should set his operations for a slow period of working out, on the basis that it is better to sell two cars of gasoline at a profit than it is to sell three cars and break even.

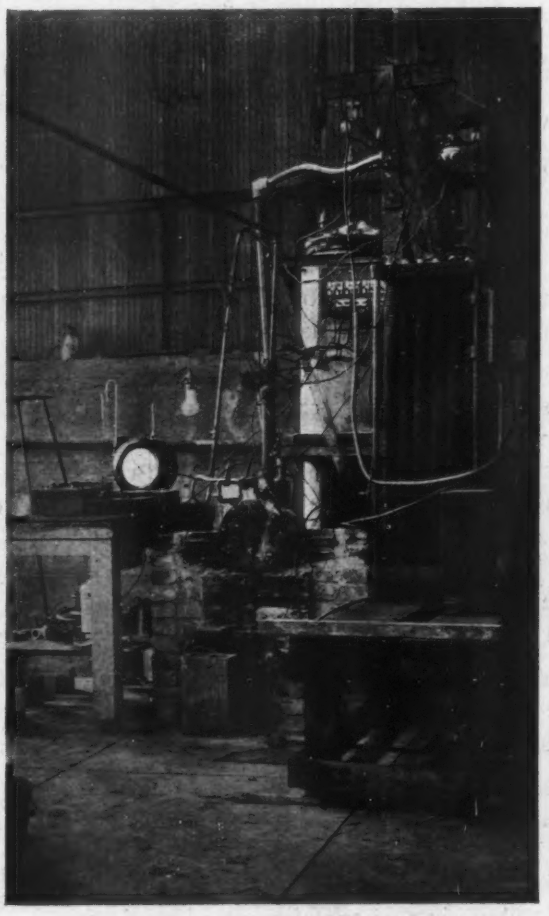
An Investigation of

By JOE E. MEYER

IT has been common practice in the petroleum industry almost since its beginning to filter certain liquid petroleum products. Filtering is generally restricted to amorphous and paraffin waxes, neutral and steam-refined stocks, and occasionally burning oil and even crude are so processed. In clarifying petroleum products by filtration, fullers earth is the most widely used of all adsorbents. Decoloration by adsorption, or "filtering," as it is termed in refinery parlance, has been defined "as the art of separating solid suspended, colloidal, and dissolved impurities from liquid petroleum products by passage through dense layers of decolorizing materials." Small particles of coke, finely divided and colloidal carbon, tarry complexes, of high molecular weight, floc, certain sulphonates, dissolved coloring matter, traces of suspended alkali and moisture, are all removed to a greater or less extent during the process of filtration.

In filtering, refiners most frequently use a vertical type of filter, provided at the bottom with a blanket-covered perforated drainage plate to hold the clay, and equipped with manholes at the top and one on the side near the bottom for charging and discharging the clay. The filters vary in diameter from 6 to 10 feet and from 14 to 30 feet in depth. Filtration may take place either with gravity or pressure feed, the latter method being preferred by most refiners. After the filter has been charged with clay, the manhole at the top is closed, and the oil to be purified is pumped in at the top under a small pressure. After the oil begins to "show through" the clay pressure is usually somewhat increased.

After the charge of clay or earth has absorbed coloring matter and impurities to the limit of its capacity, the operation is stopped, the surplus oil washed out of the earth with steam and naphtha and the earth transferred by conveyors from the filter to kilns of a suitable type, where the earth is revivified by igniting at temperatures ranging from 500 to 1400°F. Investigational work by some refiners has indicated that anti-gravity filtration (pumping the oil up through the clay instead of allowing it to per-



Representative views of the apparatus used in the processing of various raw clays. Also utilized to determine the action of the treated adsorbents on various petroleum products on a scale greater than that permitted by the conventional laboratory equipment.

The apparatus was designed by the writer and consists of an electrically heated retort with the necessary auxiliary equipment for controlling and determining temperature; providing for agitation by mechanical means; and for filtration.

The retort proper is a wrought iron, externally-heated, perpendicular, cylindrical retort, designed to insure even distribution of heat during treatment of the raw clay, or when treating an oil with a finished clay. Its capacity is approximately 100 pounds of raw clay to a charge. The retort is electrically heated and provision is made for accurate heat control by means

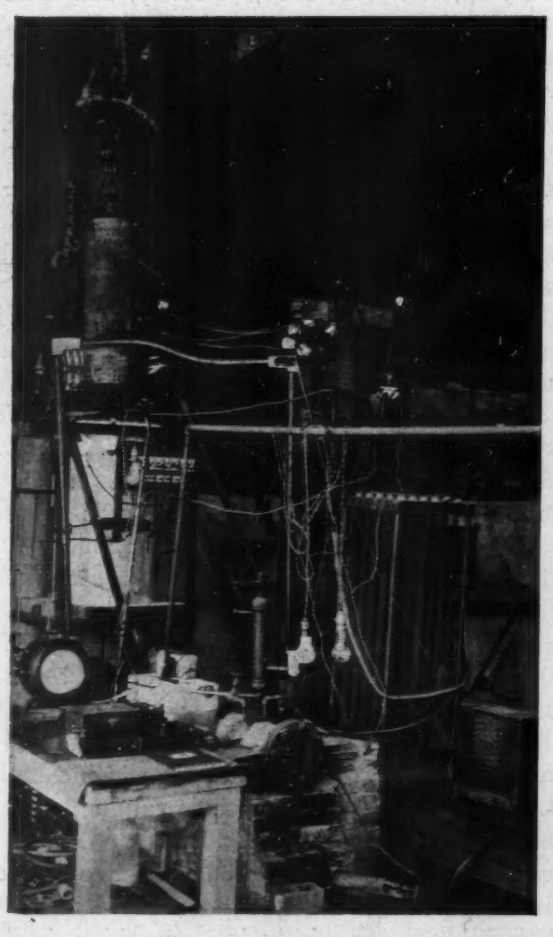
Treated Clays

In this series of two articles by Joe E. Meyer dealing with filtration clays, the author discusses methods of preparation, the phenomena observed, methods of application and results of experimentation with various bentonites. The second article will be presented next month.

of suitable rheostats. Provision is also made for the auxiliary use of steam in closed steam coils within the retort. Undue heat loss is minimized by well insulating the retort and the whole is set in a steel framework, from which it may be removed with a minimum of effort. The design of the framework permits the whole apparatus to be moved if it is so desired.

Condensation of vapors from the retort may be effected, if desired, by a single-stage water cooled condenser, which, with the accessory fittings and connections, is provided.

Temperature readings are made with a Leeds Northrup indicating pyrometer of the potentiometer type.



colate downward) will give approximately 20 per cent greater efficiency from the clay. Filters for use in anti-gravity filtration must be strongly reinforced.

As previously stated, fuller's earth is the most widely used of all adsorbents. It has been developed in this country in Florida, Georgia, Arkansas, Texas, California, Alabama and Massachusetts, but it is also found in appreciable quantities in at least 10 other states. Florida and Georgia are, respectively, the leading states in production at present. The value of the earth as a decolorizing agent is not indicated by a chemical analysis; this factor can be determined only by actually filtering oil through the earth in a small laboratory filter. Decolorization of an oil by filtration through fuller's earth has been far from the ideal process from the refiner's point of view. The main objections to the method being the comparatively low decolorizing efficiency of the clay; the large loss of oil (oil held up in the clay); and poor color control of the product.

PROBLEMS OF COLLOID CHEMISTRY

Due to these inherent faults of fuller's earth and the usual types of adsorptive clays, many refiners began to try to find or produce a filtering material which would obviate, or at least mitigate these difficulties, and they were particularly desirous of producing a material having a high decolorizing efficiency. The natural trend was to treat clays chemically and test the product. Theories were worked out on the probable action of fuller's earth on oil during the decolorizing process. Most of these theories considered the capillary surface presented to the oil by fuller's earth as being a very important factor in determining the decolorizing efficiency of the material; that tarry in the oil was present in aggregates larger than molecular aggregates; and that these aggregates were either mechanically entangled in the capillary spaces, or were adsorbed on the surface (capillary or otherwise) presented by the clay particles and their intricate and innumerable micro-

scopic canals that bring about an enormous increase in the adsorptive surface.

According to these theories then, the problem was one of surfaces, adsorption, and aggregates of near-molecular dimensions. It was thus clearly a problem in the field of colloid chemistry. It was thought probable that colloid phenomena would be encountered in this investigation and that the principles of colloid chemistry would apply. After quite a few experiments the problem was recognized as basically colloid and the observed phenomena could very often be explained on this basis.

Colloid chemistry is not as yet a very highly developed branch of the science and the known facts are not at all well organized. This made reference work difficult and tedious. After much searching in the literature it was found that the greater portion of the material of value was to be found in the text books where the fundamental principles of colloid chemistry are expressed. Although it was not uncommon to find an isolated fact of value in the literature, further effort in that field was not warranted. According all the standard treaties on colloids were perused and studied and the more promising in the field of perodical literature investigated.

It is the purpose of this report to deal with the methods finally selected for preparing a treated filtering clay from one of the best raw clays found for this purpose; to discuss some of the phenomena observed; to cite a few methods of application of the product; and to consider the results obtained on other raw clays which were examined and treated. A great number of those examined did not warrant investigation beyond the preliminary examination accorded all samples surveyed.

Bentonite is a rock that contains 75 per cent or more of the crystalline claylike minerals montmorillonite or beidellite. Many clays of the bentonite type were examined and treated in the search for a clay which would yield a product of high decolorizing efficiency. Bentonite deposits occur in beds from a few inches to many feet thick, mainly in the Tertiary but to some extent in the Paleozoic and Mesozoic rocks in many parts of the United States and Canada, and deposits have been reported from Mexico, China, and France. The principal deposits in the United States are found in Wyoming, California, South Dakota, Nevada, New Mexico, Idaho, Tennessee, Kentucky and Alabama. Smaller deposits have been reported from at least twelve other states. The clay found to have the highest decolorizing efficiency after treatment was a deposit of bentonite locally known as otaylite, located four miles east of Otay in San Diego County, California. The bentonite bed consists of numerous thin strata of colors ranging from white to green, pink and chocolate. The composition of the different colored layers is the same and resembles that of montmorillonite. The white specimens always show black specs which are an oxide of manganese, and these specs are usually found in the other colors of the clay also. The fracture is peculiar, the individual particles having no definite cleavage in any direction; the fracture is not exactly conchoidal but this most nearly describes it. The clay is likely to break in any direction, leaving sharp lines, corners and angles, or perhaps smooth surfaces. The bentonite from this deposit is always quite moist and contains about 30 per cent of water. Upon exposure to the air the large particles of the clay break down into many smaller ones, the drying and cracking being similar to that of a gel. A week's exposure to the air with stirring reduces the moisture content of the clay to about seven per cent.

OPINIONS OF BENTONITE

J. Alexander (*"Bentonite": Colloid Symposium Monograph, Vol. 2, 1925, pps. 99-105*) concludes that much of the substance of bentonites has not progressed beyond the colloidal stage, as ultramicroscopic study showed fully one-half of the particles were of ultramicroscopic size. Bentonite is considered by other investigators to be a mixture of colloidal silicates and fine-grained kaolinite (*Schurecht, H. G., and Douda, H. W., "The properties of some claylike materials of the bentonite type": Jour. Am. Ceram. Soc., Vol. 6*, 1923, *p.* 940), or a typical suspensoidal colloid (*Coward, H. F., "Sedimentation of bentonite": Jour. Chem. Soc., Vol. 125, 1924, p. 1470*), and Ross and Shannon (*Ross, C. S., and Shannon, E. V., "The minerals of bentonite and their physical properties": Jour. Am. Ceram. Soc., Vol. 9, 1926, pps. 77-79*), state that solid natural bentonites contain no gel colloids and that few crystal particles are as small as colloidal size. The findings of these investigators indicate that bentonite is commonly composed of montmorillonite and less often of beidellite, minerals resembling micas.

The mineral montmorillonite is designated as $(Mg,Ca)O.\ Al_2O_3 5SiO_2.nH_2O$), with n equal to about 8. Beidellite was named by Larsen and Wherry (*Larsen, E.S., and Wherry, E.T., "Beidellite, a new mineral name:" Jour. Wash. Acad. Sci., vol.* 15, 1925, *p.* 465), and they assigned to it the formula $Al_2O_3.3SiO_2.xH_2O$, in which x is frequently equal to 4 and the alumina is replaceable by other oxides; Ross and Shannon (*Ross, C.S., and Shannon, E.V., "Chemical composition and optical properties of beidellite:" Jour. Wash. Acad. Sci., vol.* 15, 1925, *p.* 467),concluded that the mineral beidellite consists of isomorphous series of $Al_2O_3.3SiO_2.nH_2O$ and $Fe_2O_3.3SiO_2.nH_2O$, with n equal to approximately 4 and with water replaceable by alkali or alkaline-earth oxides. Crude bentonite may include varying amounts of other minerals as impurities and this explains the differences in the various published analyses of crude bentonite.

Although varying widely in composition, bentonites have many properties in common. The colloidal prop-

erties of bentonite have been attributed to a felted texture and a micaeous structure, in which the crystals have appreciable size in two dimensions but a thickness of colloidal magnitude and also have the property of splitting up into still thinner plates, the texture supposedly allowing water to penetrate the mass quickly, wet the surface, and force its way between the micaeous leaves of the crystals (*Wherry, E.T., "Bentonite as a one-dimensional colloid:" Am. Mineral., vol.* 10, 1925, *p.* 120.)

Analyses of crude bentonite show that it is composed essentially of silica, alumina, and water, which make up approximately 90 per cent of the material, in the ratio (mean of 15 analyses) of 61:18:10. The remaining constituents are chiefly iron, magnesia, lime, and the alkalies (*Spence, H.S., Bentonite: Canada Dept. Mines, Rept. 626, 1924, 35 pp.*)

TABLE 1
Analyses of Bentonites

Composition of Sample	No. 1[1]	No. 2	No. 3	No. 4	No. 5	No. 6
SiO_2	49.56	55.22	62.4	63.8	60.18	61.5
Al_2O_3	15.08	21.00	19.3	17.9	26.58	21.2
Fe_2O_3	3.44	3.61	.1	1.2	....	.1
TiO_2	.40	....	...	...	....	...
CaO	1.08	4.94	1.28	3.1	.23	.4
MgO	7.84	3.04	3.5	5.4	1.01	1.1
K_2O	...	....	1.5	Tr.	1.23	.2
Na_2O	...	1.56	2.0	Tr.	....	1.8
H_2O 105°	...	....	6.0	16.7	....	...
H_2O Total	22.96	10.28	8.77	22.88	10.26	8.61
Loss 105° to 1,000°	....	....	4.90	7.30	....	...

1. Otaylite (pink), Otay, Calif. (Ross and Shannon, p. 88, work cited.)
2. Bentonite, Ardmore, S. Dak. (Ladoo, Nonmetallic Min., 1925, p. 92.)
3. Kentucky bentonite. (H. C. Vacher, Tech. Paper 438, Bureau of Mines.)
6. Bentonite, near Fallon, Nev. (H. C. Vacher, p. 10, work cited.)
5. Type bentonite, near Rock Creek, Laramie Basin, Wyo. (Ladoo, p. 92, cited.)
6. Bentonite, near Fallon, Nev. (H. C. Vacher, p. 10, work cited.)

When otaylite is placed in water it will rapidly disintegrate into a fine mud, swelling a little. On being allowed to stand for several hours it will settle, leaving the supernatant liquid clear. Water thrown on the outside of lumps of this clay forms an impervious coating.

PREPARATION FOR TREATMENT

The clay was prepared for acid treatment by grinding in an impact mill after first having been reduced to particles of small size by air drying. This drying process reduces the moisture content to about seven per cent as was previously mentioned. The Raymond mill was found to be a very suitable machine for the purpose of grinding the clay. The material was reduced to about 85 per cent through 200-mesh. This was found to be about the correct degree of fineness for the most effective acid treatment.

The clay was treated with various acids. It was found that sulphuric acid gave the best results, although other acids, such as acetic and hydrochloric could be used. After much experimentation to arrive at the best concentration of acid in the treating solution it was found that a sulphuric acid solution (20 per cent of concentrated commercial grade, 66° Baume, H_2SO_4 by weight) was the best suited. Bentonites may be divided into two groups according to the difference in action of sulphuric acid on their alumina content. The Wyoming type bentonite which contains alumina resistant to the action of sulphuric acid has been called "bentonite," while the type in which the alumina is mostly dissolved by sulphuric acid has been termed "subbentonite." The refining of oil by bentonite apparently depends largely on the selective adsorption of coloring matter, both suspended and dissolved; but chemical action to some extent is also indicated according to the studies of Rogers, Grimm, and Lemon (*"Adsorption studies on the decolorization of mineral oils:" Ind. and Eng. Chem., vol.* 18, *p.* 164). Acid-treated subbentonites are best suited for this purpose. The bentonites similar to the Wyoming type material (without soluble salts) can be differentiated from sub-bentonites by their marked swelling and dispersion when placed in water. This is an important test in the preliminary examination of clays. In treating otaylite with sulphuric acid, the amount of net clay (excluding moisture) was determined, and 50 per cent of this weight of treating solution (20 per cent of sulphuric acid by weight) was used in the treatment. If the amount of the treating solution was varied appreciably as the amount decreased, the efficiency of the finished clay also decreased and the same was true if the acid content of the treatment was increased. The amount of treated clay yield decreased as the concentration of the treating solution was increased. As the concentration of the treating acid was increased the pulp which the solution forms with the clay increased in consistency and the heating and uniform treating conditions to be desired became more difficult of accomplishment. From the foregoing observations it is obvious that 50 per cent (by weight) of the quantity of the clay to be treated of a sulphuric acid solution (20 per cent of H_2SO_4 by weight) is the optimum quantity and concentration of treating solution.

After the clay has been thoroughly mixed with the treating solution, and a uniform pulp or mud obtained, the pulp was heated to a temperature of 210° to 220°F., and held at this temperature, with occasional agitating, for several hours. During this treatment the acid attacks the clay, transposing a portion of the silicates to sulphates, and aluminum and magnesium sulphates are obtained in large quantities. Some acid remains after the cooking, which does not react with the clay, and this acid, presumably, represents a sort of equilibrium condition between the acid and the clay. All of the carbonates in the clay are destroyed. The silicic acid formed in this treatment precipitates immediately. The effect of sulphuric acid on bentonites may be used to differentiate bentonites from subbentonites; the former are but slightly attacked, or altered, while the latter are attacked so that their original properties can not be restored.

After cooking, the hot pulp was diluted with water

and agitated with air to mix thoroughly and dissolve as much of the salts and acid as possible. After vigorous agitation for a short period and settling until the water is comparatively clear, the water is drawn off. Recovery of the salts from this wash water can be made if it is so desired. The residue from washing should contain little or no free acid. The acid treatment removes considerable alumina and the combined water destroying the colloidal state. After the final wash the pulp contains from 75 to 80 per cent of water, and is in a distended condition. Part of this water can be removed by filtration. It is advisable to use a continuous filter for this purpose and an Oliver rotary was found to be satisfactory. Filtration will reduce the water content from 80 to approximately 65 per cent. The clay at this point is in a caked form and is firm until handled or disturbed. If handled, the cake becomes soft and free water appears. This is characteristic of filter cakes having this general structure and has been observed and recorded in the literature by several investigators.

The drying of the treated clay requires a close and well regulated control of temperature if heat is used; the clay being very susceptible to overheating and consequent impairment of efficiency. Drying of the treated clay on a small scale is best accomplished by simply exposing the clay to the air. Air drying in the manner suggested will reduce the moisture content to about 30 per cent. To obtain a "dry" clay the application of heat, or some special method of air drying, becomes necessary. Clay to be used in the treatment of gasoline should be a "dry" clay, as such clay is more efficient.

The structure of the treated clay is so delicate that overheating will change it readily. The clay residue after acid treatment resembles silica gel. On losing water the pores or capillaries of the clay are filled with air; these capillaries have very thin, delicate walls, and are unstable chemically; they are amorphous in character and have a tendency to crystallize, thus reducing the amount of surface or its properties, which will in turn change the decolorizing action of the clay. Application of too great a heat tends to promote this crystallization, and still greater heat has the effect of sintering the surfaces. There is a limit, however, below which the efficiency of the clay will not fall, regardless of the heat applied in drying. Even though the clay be heated to a dull red, the decolorizing value of the treated clay still remains several times that of a good fuller's earth. A continuous dryer with accurate temperature control permitting close regulation should handle without difficulty, and with good efficiency, a treated clay of this type. The more efficient the clay produced, the less will be required in clarifying an oil to a desired color, and the less oil will be lost in the clay removed by filtration. The loss of oil in the filtering medium becomes very considerable when the oil under treatment is a heavy dark colored lubricating oil and the efficiency of clays used in decolorizing oils of this type is a highly important factor.

There is at present no standard and accepted method for testing and evaluating the decolorizing properties of a clay. Every user of clay has some test which shows in a more or less empirical manner just what is most suitable for his particular needs.

A test for decolorizing efficiencies of burned fuller's earth has been proposed by J. B. Hill, L. W. Nichols, and H. C. Cowles, Jr., of the Atlantic Refining Company, Philadelphia, Pennsylvania. (*Oil and Gas Journal, August* 6, 1925, *p.* 119.) This method measures the decolorizing action of a burned earth on a standard solution of dye. Although adsorption is important in decolorizing oils, probably no good method will be devised for evaluating bentonites for oil refining by the use of dye adsorption as a criterion. This is evident from tests which show that crude bentonites which have little bleaching value may have a very high dye adsorption in comparison to excellent acid-treated bentonites; tests also show that although 200-mesh acid-treated bentonite adsorbed about four times as much dye as 50-mesh material from the same lot, the action of the two clays in decolorizing oil was nearly the same; and of greater significance, the fact that conditions in oil decolorization are not those of any single adsorption of a solute from any single solution.

Tests in the laboratory approximating plant practice are preferable in determining the relative decolorizing efficiencies of the materials employed in clarifying petroleum products by filtration. The relative value of different materials for clarifying a certain oil by the contact process, under fixed conditions, may be determined by adding 2, 5 and 10 gram samples of the pulverized material to 50 c.c. of oil heated to 125°C., raising the temperature to 150°C., agitating at that temperature for 30 minutes, and then filtering through a filter paper. (With some oils a higher temperature to effect efficient decolorization). The resulting colors are then compared and the relative value of the decolorizing agents determined. A yellow color free from any reddish shade is preferable.

Another method is as follows: select an oil which is color stable and which has a color light enough to be taken accurately by some standard method, the N.P.A., preferably. Add 20 grams of some standard earth to the oil (100 c.c.), agitate and filter as directed in preceding method, and take the color of the treated oil. Apply successive small samples of a treated clay to 100 c.c. of the oil to be clarified, with agitation, and procedure as previously directed, until the color exactly matches that of the oil treated with fuller's earth. The ratio between the amount of standard earth used and the amount of treated clay (by weight) may be termed the efficiency of the treated clay as compared with an earth of known value. Strictly speaking, this is not the true efficiency, but it does represent the ratio of decolorizing values.

Indian Increases Capacity And Flexibility

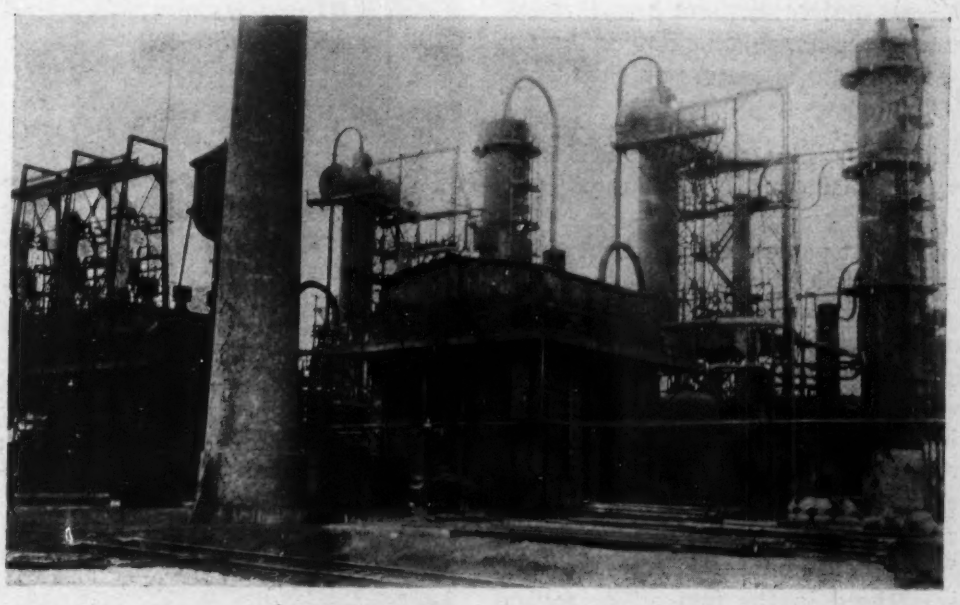
By GEORGE REID
Associate Editor

CRUDE oil distillation facilities at the Lawrenceville, Illinois, refinery of the Indian Refining Company consists of two large tube stills of the Cross type provided with two bubble type fractionating columns. The original installation placed in operation several years ago included but one Cross fractionating column working in conjunction with each of the tube stills. These stills had a rated capacity of 5000 barrels each daily.

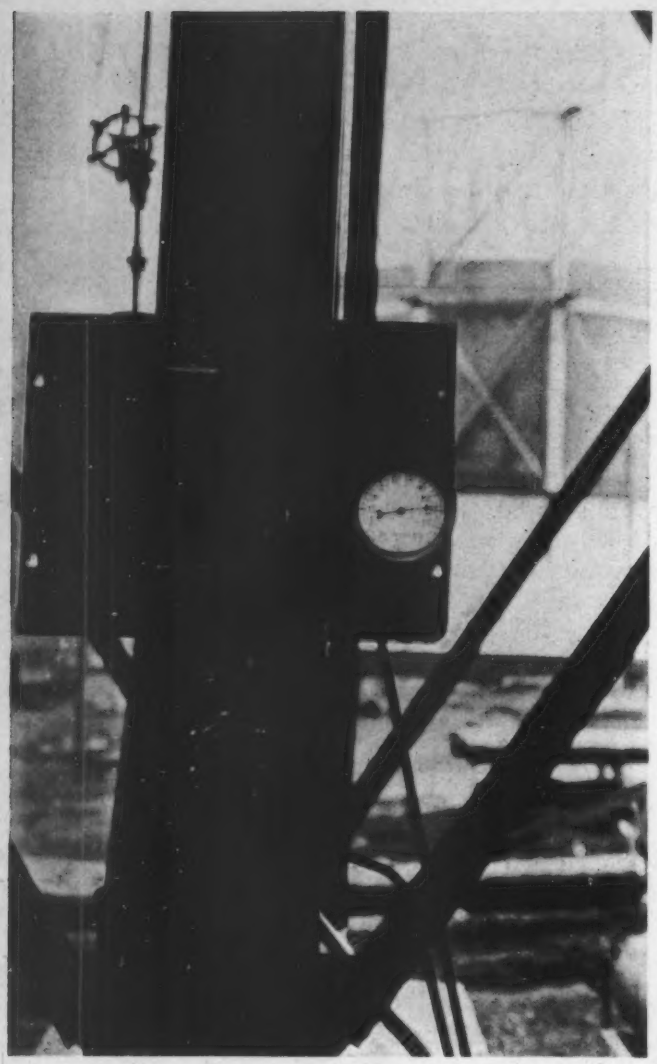
During the past year the company desired to increase its crude charging capacity to secure greater flexibility in operation. Distillation equipment was needed which would perform efficiently at varying rates of charging, ranging from 6000 to 9000 barrels of oil per day per still. In addition it was desired to secure more closely fractionated streams and to secure all products from gasoline through the gas oil fraction in one pass through the units.

With no change in the tube stills proper, and through the installation of one more bubble type fractionating column on each still, the desired results were secured. The rated capacity of the plant is now 15,000 barrels per day, although each still has handled oil over long periods at the rate of 9000 barrels per day.

Since the two pipe still units are identical in design, only one unit is shown in the accompanying flow chart for the remodeled pipe still operation. The units alternate in processing Kentucky crude oil of 34-34.5 A. P. I. gravity, yielding about 35 per cent gasoline, and Illinois crude of 31-32 A. P. I. gravity with a gasoline content of approximately 31 per cent. The stills are equipped with tube coils made up of 3¼-inch I. D. and four-inch O. D. tubes, with 13,500 feet of tubing in each retort. Crude is metered to the units through National meters as it leaves the two-stage Worthington centrifugal pumps discharging the oil through heat exchange apparatus. Meter



Crude distillation equipment consisting of two units at Indian Refining Company's plant at Lawrenceville, Illinois. Flash towers working in conjunction with bubble tower are shown at the right of the first unit.



Ammonia leaving drums enroute to combat corrosion in vapor lines and condensers pass through a level of kerosene in the home-made device shown, indicating the flow to operators on shift.

measurement is checked against gauges of field storage and accuracy is satisfactory after four years of service.

Crude to the unit first passes through two vapor-to-liquid exchangers installed on the gasoline vapor line. From this equipment it goes into a water settler before being further heated in a liquid-to-liquid exchanger placed on the kerosene line between the kerosene flashing chamber and cooling sections. Further heat is picked up in a similar exchanger on the gas oil line in front of the gas oil cooler. In addition to securing preheat on the crude oil this practice tends to reduce cooling and condensing equipment and to lower water consumption at these points. Final preheat is secured in the fuel oil or topped crude exchangers. From this point the hot oil at a temperature of around 300°F. is taken to a flash tower or evaporator where the light gasoline vapors are removed to pass through the Cross bubble tower, and thence to condensers and storage. This stream is combined with the gasoline stream from the new or second bubble tower to make the finished straight run motor fuel product.

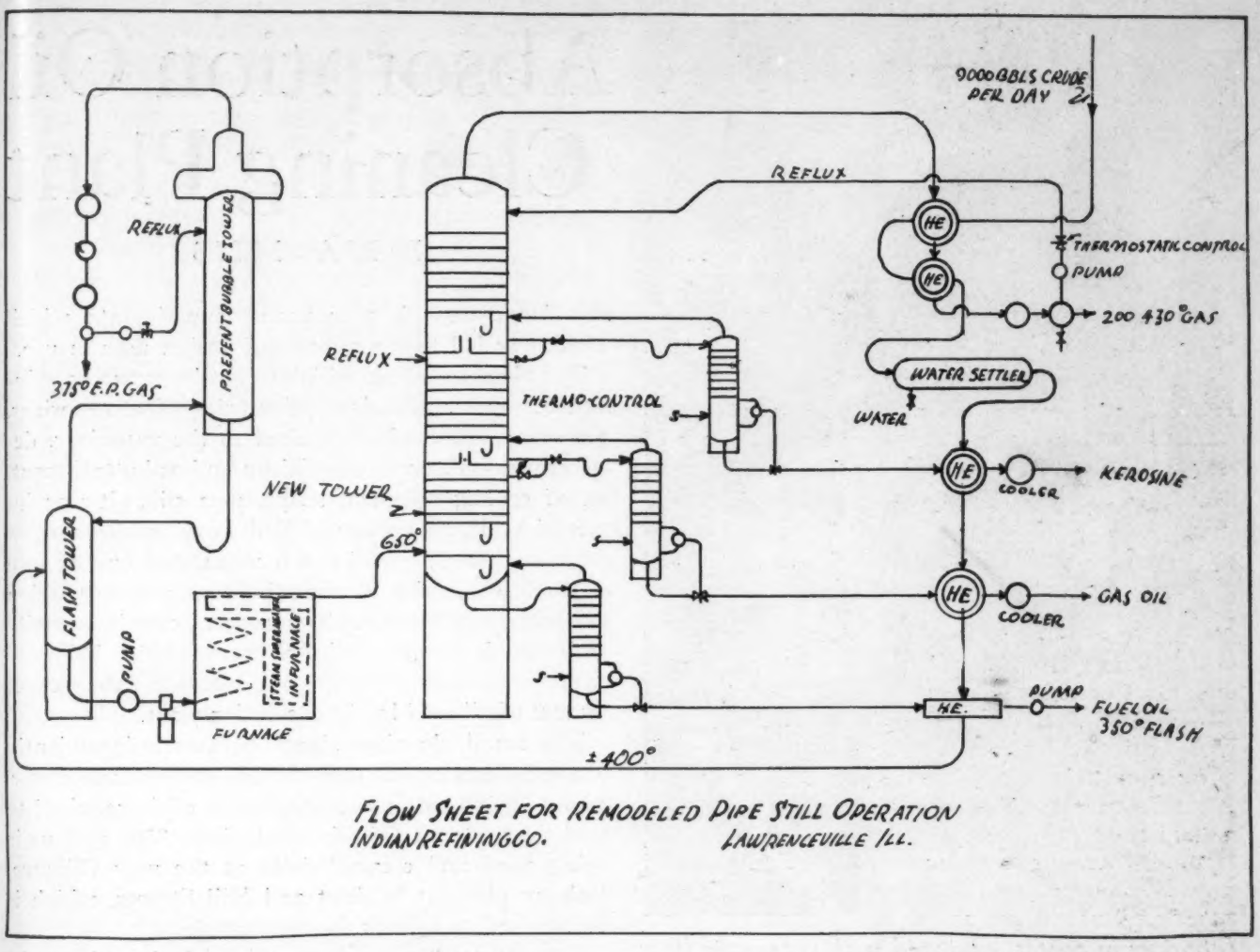
CRUDE FLOW AND BUBBLE TOWER

In this design which incorporates the water settler after the first preheating in gasoline vapor-to-crude oil exchangers, another use is found for the old Dubbs reaction chambers which were discarded some time ago and replaced by the larger type of chamber. The Dubbs chambers, because of their design, lend themselves nicely to the improvised work as settlers with but little expense.

A centrifugal crude pump picks up the oil from the bottom of the primary separator and acts as a booster pump discharging to Worthington five- by 10-inch vertical triplex pumps which discharge to the tube still. All pumps are electric motor driven with the motors installed in separate rooms with drive shafts through brick walls.

Through the evaporation of 12 to 15 per cent of the gasoline content in the preheating process the pipe still capacity is proportionately increased, nor does it have to handle these light gas forming vapors.

Details of assembly of tanks and soda ash storage house are shown. Soda ash soultion is pumped into the crude charging line from the two smaller tanks in the foreground. All three tanks have conical bottoms.



Flow Sheet for Remodeled Pipe Still Operation
Indian Refining Co. Lawrenceville Ill.

Crude enters the tube still at around 250°F. and is heated to 650°F. to enter the bottom of the main or second fractionating column at this temperature. This heating is sufficient to remove gasoline, kerosene, and gas oil fractions but is not hot enough to cause any cracking of the lubricating oil fraction. In charging 6000 to 9000 barrels daily through tubes of 3¼-inch diameter high velocities are secured.

In the bottom section of the tower, as shown in the flow chart, the residuum or base is separated to pass out of the conical bottom into a specially designed Winkler-Kock flash tower, size three feet by 20 feet. Here the base oil is flashed with superheated steam at 650°F. which effects the removal of any light products in the residual oil. Such vapors as are removed by flashing are conducted back into the lower section of the bubble tower. The base oil is conducted away through heat exchangers and storage. It is later preheated and taken to the primary vacuum distillation unit of the Gover's process and a large percentage recovered as wax distillate.

FRACTIONATION AIDED BY FLASHING

The vapor stream passes upward into the three sections of the large Winkler-Koch bubble tower. In the next section above the gas oil fraction is condensed, removed from the side of the tower and flashed with superheated steam, returning light undesired vapors back into the tower. This flash section or tower is 30 inches by 18 feet in dimensions.

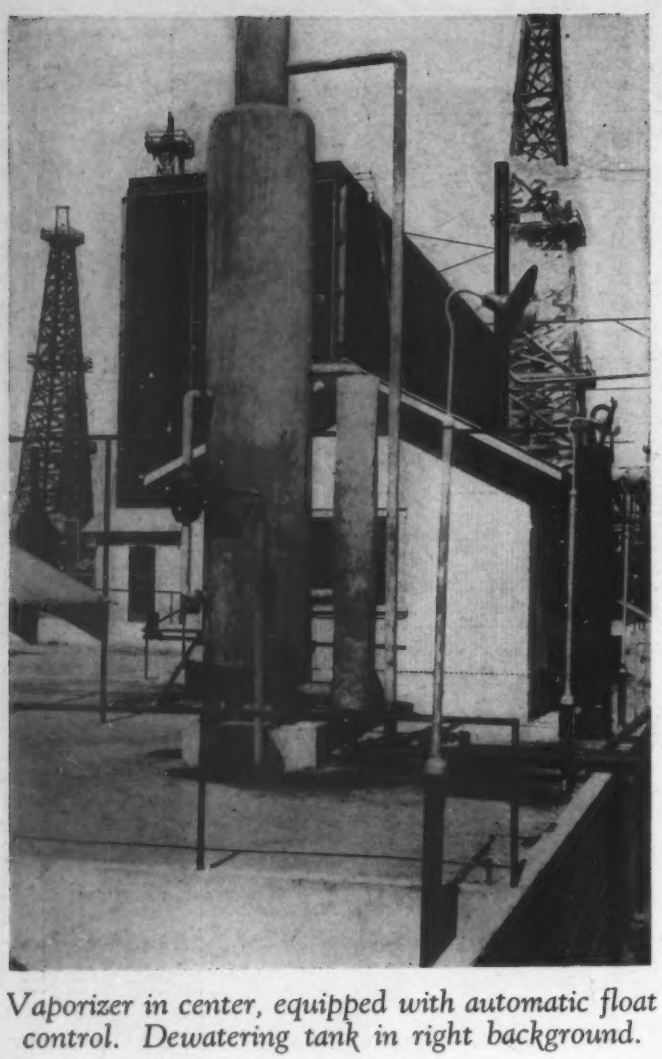
In the next section above the gas oil compartment the kerosene fraction is condensed. This compartment is "trimmed" by refluxing kerosene distillate into the top of the section. Condensed kerosene distillate is withdrawn from the side of the tower through a flashing chamber, 26 inches by 18 feet in dimensions, where superheated steam at 650°F. is employed to remove any light vapors not liberated in the tower proper. Such vapors return to the tower. The remaining gasoline vapors are fractionated in the uppermost section of the column. Finished gasoline is refluxed over the top of this section for trimming and temperature control, holding this temperature at 320°F.

From each of the flashing chambers the hot liquids pass through heat exchangers, preheating the incoming crude, and then to coolers and storage. Gasoline vapors are employed in a like manner to heat the crude, and after condensation the gasoline passes through a large water leg from which the "trim" pumps take suction at a point near the top. A water leg or separator is also provided on the kerosene stream line, from which a small trim pump derives

(Continued on page 114)

Absorption Oil Cleaning Plant

By BRAD MILLS



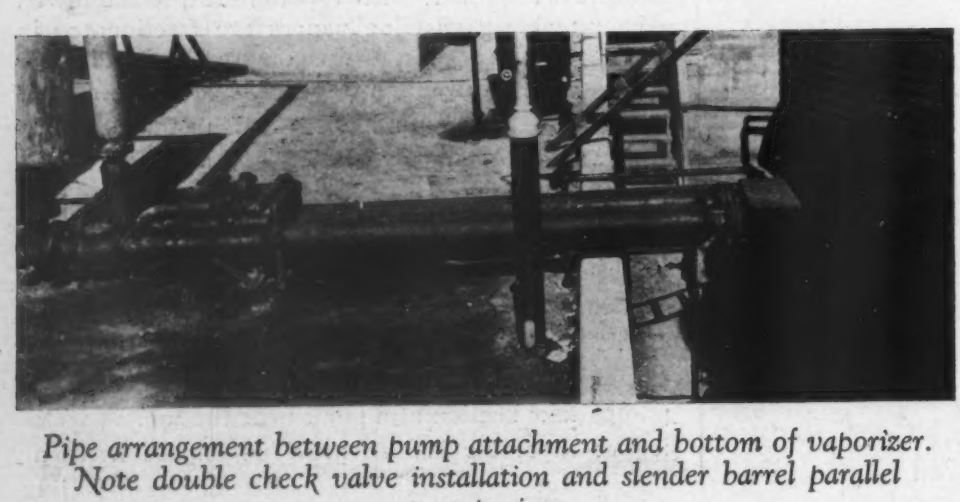
Vaporizer in center, equipped with automatic float control. Dewatering tank in right background.

INSTALLATION of small plants for continuous cleaning of absorption oil has been completed at all natural gasoline plants operated by Gilmore Gasoline Company and Gilmore-Dabney Gasoline Company in the Long Beach field, following the invention and perfection of the new system by company engineers. Prior to adoption of the continuous treating system, the loss from oil changes and lower efficiency while operating with dirty absorption oil was large enough to warrant experiments which ultimately led to the successful design now in use.

The cleaning plant, which might be termed a miniature refinery, consists principally of a vaporizer, automatic float valve attached to the vaporizer, dewatering tank, pump, special pump head attachment, set of cooling coils and simple pipe still. It was invented by E. Newman and William Shellshear, company engineers, who have incorporated one or two features which they are withholding, pending action by the patent bureau. The general circuit is easily understood, however, the primary object being to clean automatically by vaporization the exact amount of oil used by the absorption plant.

The small cleaning plant operates independently of the main gasoline plant and is entirely automatic. About 12,000 gallons of absorption oil is required to load the system. Of this total, about 3500 gallons is being used and cleaned daily at the new Gilmore-Dabney plant at Walnut and Hill Streets, which is being used as a basis for this article.

The oil used in the system is picked up from the equalizing tank at a pressure of 35 pounds and a temperature of 320°F. It is admitted to the special vaporizer by means of a Fisher float control, entering at a point about one-third up from the bottom. A specially designed pump, equipped with a head which makes it possible to block off the regular intake and discharge, is used for forcing the oil dropping down in the vaporizer through the remainder of the circuit. The pump attachments has remote valves water-jacketed between the valves and the pump proper and operates by surges, the same oil remaining in the pump at all times. The oil then goes to the tube still at 400°F. and returns to the vaporizer at a point near the top at a temperature of 450°F.



Pipe arrangement between pump attachment and bottom of vaporizer. Note double check valve installation and slender barrel parallel to vaporizer.

Vapors are constantly coming off the top of the vaporizer, going to the cooling coils and to the dewatering tank, where oil is removed and returned to storage.

The absorption oil constantly makes the circuit in the installation, the amount

admitted being controlled by the Fisher float control on the vaporizer. As the oil is vaporized and discharged at the top of the vaporizer, the float control opens, admitting more oil from the absorption system.

Although the oil is picked up at the equalizing tank under a pressure of 35 pounds, this pressure is lost in the vaporizer and the system when admitted by the float control. The slender vaporizer is open at the top for free exit of vapors for the dewatering tank. Pressure in the tube still is only enough to push oil through the series of return bends, and probably is not more than two pounds.

NOT FILTERING PROCESS

The residuum accumulates in the bottom of the vaporizer, which is about three feet in diameter and 15 feet high. Removal of this accumulation necessitates shutting down of the system for only a short time.

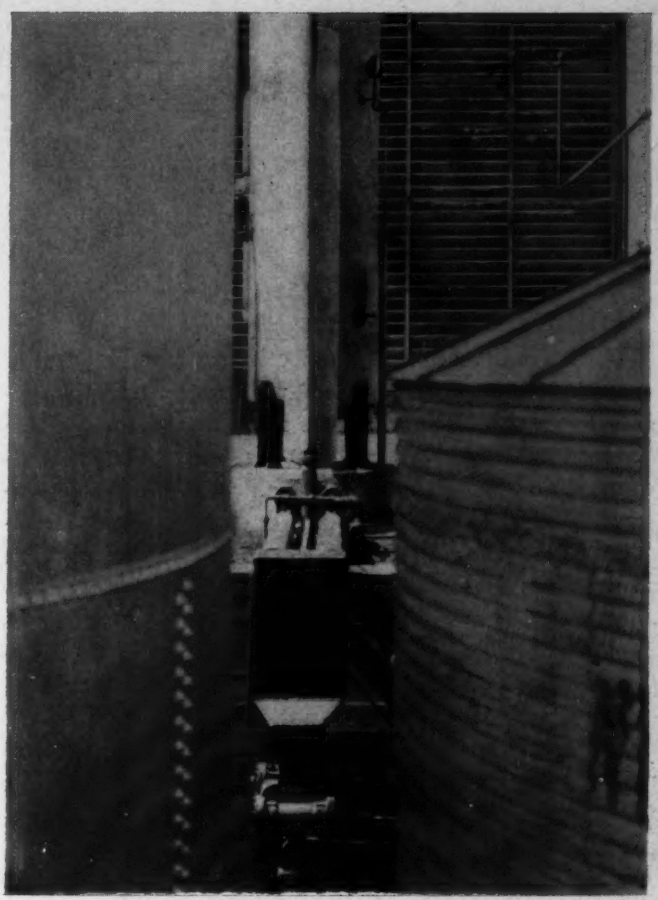
The system is not a filtering process, as has been erroneously reported, but cleans the oil strictly by vaporization. A slight agitation is maintained in the vaporizer and the fact that the oil leaves the vaporizer at a higher temperature than that recorded when it enters from the equalizing tank is accounted for by the return of a large portion from the fire still. It is natural that vaporization would not be complete at an entry of 320°F., the oil dropping down being picked up, or pushed over, by the pump and constantly circulated through the fire still.

EQUIPMENT DETAIL

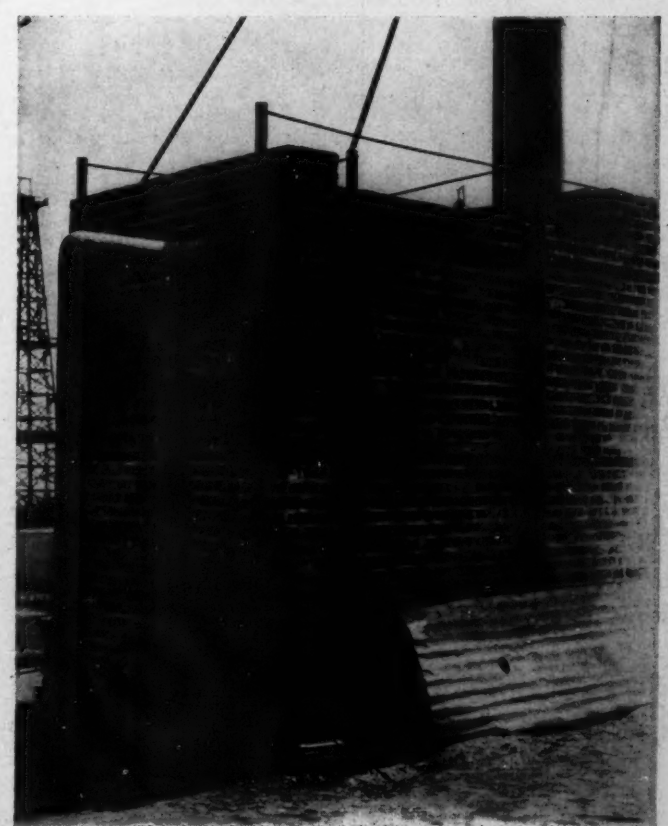
The small still is made of two-inch pipe and a series of return bends. It is covered with brick, being a rectangular structure about six feet wide, 10 feet long and eight feet high, and having 14-inch walls. Fuel gas is admitted to the burner by thermostatic control which is operated by temperature of outgoing oil. As the quantity of oil is increased, the regulator admits more fuel and maintains an even temperature. When 3500 gallons of oil per day is treated, only around 40,000 cubic feet of gas is used. At a cost of only five cents per thousand cubic feet, it is obvious that total fuel cost is $2.00 per day.

The only parts of the installation not made public by the inventors are the special pump head and the barrel placed upright and in parallel with the vaporizer. The pump head consists of a rectangular steel box attached to the pump on top of the fluid end, but this arrangement is chiefly to provide a large water jacket for cooling. Two three-inch pipes connect the pump head and the discharge from the vaporizer. They are water-jacketed by welding six-inch pipe over the main three-inch carriers. A double set of check valves, located near the bottom of the vaporizer, control the flow of the oil between the vaporizer and the fire still. Small lead lines take off from the three-inch lines, check valves being placed both in these lines and the three-inch lines.

(*Continued on page 114*)



Special pump attachment on top of fluid end connects to bottom of vaporizer by three-inch water-cooled pipes.



Small fire still.

The Fractionation of Absorption Oil

WHILE on first inspection it would seem a comparatively easy matter to strip the absorbed constituents from an oil, many factors enter into the problem to increase the difficulties. One not familiar with the actual conditions encountered in absorption plant operation might be inclined to think that due to the fact that the oil from which this material is to be fractionated can be selected and that this same oil is used over and over again in a continuous cycle, the problem of fractionation would be one for precise and accurate mathematical analysis. Such is not the case, as there are limiting factors and variables over which there is no control that go to make the problem one of the most difficult encountered in industrial distillation. Fractionation as applied to absorption plants is only one link in the operating cycle, but a very important link. Difficulties peculiar to natural gasoline plant operation distinguish the methods used to fractionate from those encountered elsewhere.

VARYING NATURE OF GAS

Fractionation is the opposite of absorption inasmuch as one is a gas stripping operation and the other is a liquid or oil stripping operation. In an absorption plant the nature of the material which the fractionator must strip from the oil is dependent upon the characteristics of the gas undergoing absorption, which is of an ever changing nature. It is these variations in the nature of the gas undergoing treatment that cause a fractionating column to periodically cease functioning properly and start carrying over oil into the gasoline in form of end-point or else cease satisfactorily stripping the oil. This will frequently occur when all other conditions are constant. Distillation is a vapor pressure phenomenon, the total pressure on fractionating tower is the sum of the partial pressures of the vapors and gases within the system. The lighter gases have a higher vapor pressure than the heavier gases and hence have a greater capacity for volatilizing the heavy constituents of the oil. It is noticed that the end-point of the gasoline is more likely to go off on cold days when the gas undergoing absorption is lean. This is for the reason that regardless of how wet or lean the gas is, if the absorption pressure and temperature remains unchanged the oil is saturated to practically the same vapor pressure regardless of what the distillation analysis shows. By the way of illustration: an oil is saturated with ethane to 20 pounds vapor pressure and the same oil saturated with butane to 20 pounds vapor pressure, both at 80°F. at say 320° F., the oil saturated with ethane would show a vapor pressure much higher than the one saturated with butane. The difference of pressures on elevation of temperature is very marked with propane, isobutane and butane. Where the gas coming into the absorber becomes richer in the heavier gasoline hydrocarbons, the fractionating column may fail to completely strip the oil. Secondary fractionation after a hot partial condenser eliminates the troubles incident to variations in the nature and percentage of saturation of the absorption oil, as practically complete separation between the oil and absorbed material is assured at all times by operating the main column to strip under the heaviest load, even though oil is distilled over with the outlet vapors from the column at other times. An auxiliary column will be cheaper from the standpoint of initial cost than trying to build too much into one main column. Operation is easier, average yields higher and control is better, where an auxiliary column is used with a main column. At least such has been the experience of the writer.

LOW OIL SATURATION

From the viewpoint of absorption, low oil saturation is frequently desirable in order to effect complete stripping of the gas. For purposes of fractionation it is better to have a high oil saturation. The problem is what to do without sacrifice of plant efficiency and maintain complete stripping of both oil and gas. Low fractionating pressure gives better stripping conditions for low oil saturation. Steam has a similar action. The efficiency of the subsequent condensation of fractionated vapors is adversely affected by either low pressure or steam. The oil temperature can be raised but this will probably injure the absorption capacity of the oil. Where steam is used, followed by compression of the tail gases after condensation of the main product under fractionator pressure, water enters the compressors as

FIFTH ARTICLE

By I. N. BEALL
Chemical Engineer

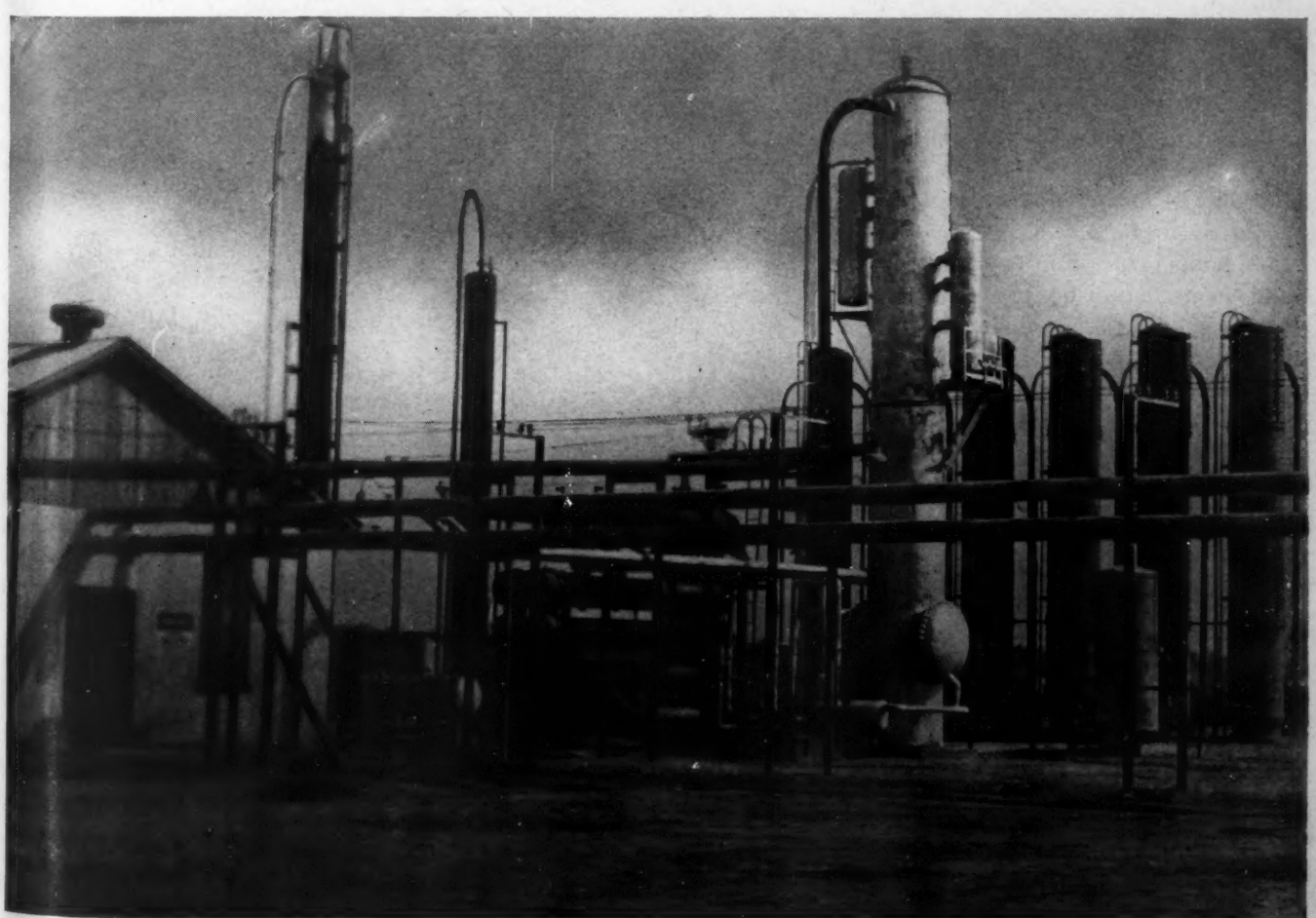
IN this fifth article of the series by I. N. Beall dealing with the practical application of technology to the manufacture of natural gasoline the author presents the second part of his discussion of problems of design and operation of fractionating equipment. This discussion of fractionation will be carried still further by Mr. Beall in another article to appear in these columns next month.

vapor saturation. One satisfactory answer to the problem of fractionating low saturated oil is to strip with selected vapors and compress the vapors direct from the fractionating column before any condensation takes place other than for the control of end-pointing by passing through a hot partial condenser. The subject of vapor compression will be dealt with more fully in a subsequent article. Under the aforementioned conditions the fractionation can be made to function without sacrifice of efficiency in the other steps of the operating cycle.

HIGH PRESSURE FRACTIONATION

High pressure fractionation would be preferred were it not for the fact that higher oil temperatures are required. Where steam is used to aid in stripping and to lower the temperature of distillation, there is danger that the pressure may cause the steam to condense and emulsify the oil. Higher fractionating pressures call for greater steam consumption and higher oil temperatures to avoid emulsification.

Excessive quantities of water separate at the reflux condenser, causing a flooded condition on the upper fractionating trays. A high operating pressure can however be maintained by using a secondary column without attempting to separate all oil from the vapors from the first column. A hot condenser and



water separator is used in conjunction with such an arrangement. The heat requirements are greater but the compressor requirements are less where fractionation is carried out under high pressure. Pressures in excess of 30 pounds gauge are arbitrarily assumed as high pressured.

THE UTILITY OF THE MOL UNIT

As has been discussed in previous articles on natural gasoline plant operation, the mol unit may be either expressed in pounds, gallons, or cubic feet of vapor. Seemingly unrelated data can be correlated by the use of the mol unit. For example the latent heats of vaporization can be computed with a remarkable degree of accuracy by its use. A mol-pound of all the hydrocarbons requires approximately 11,000 B. t. u. for vaporization at their boiling points at atmospheric pressure. This may be taken as an average value for all the hydrocarbons: for example a natural gasoline. The molecular weight of propane is 44. 11,000÷44=250 B.t.u. Latent heat of evaporation for one pound molecular weight of pentane is 72; 11,000÷72= 153 B.t.u., and so on. The mol-pound is 373 cubic feet of vapor at 60°F and four-ounce pressure, therefore if 3,730,000 cubic feet of vapor is absorbed

$$\frac{3{,}730{,}000}{373} \times 11{,}000 = 110{,}000{,}000 \text{ B.t.u.}$$

is given off as heat of absorption or as heat of condensation. An equivalent amount of heat must be supplied to effect evaporation. It will be noted that as the molecular weight increases, the latent heat of evaporation per pound decreases. This is true also for pressure, the decrease equals approximately 0.5 B.t.u. per pound increase of pressure between atmospheric and 50 pounds gauge. As more heat is required to raise the absorbed material to distillation temperature due to an increase in specific heat and an increased boiling point, and also the accompanying heat requirements for the absorbent oil increase, a low fractionator pressure favorably effects heat economy.

The mol unit is useful for purposes of estimating what the vapor pressure of a given hydrocarbon mixture will be from the Clausius-Clapeyron equation where 11,000 is used as the average heat of vaporization per mol-pound. This equation is written as follows in its integrated form:

$$\log_{10} P_2 - \log_{10} P_1 = \frac{11{,}000}{2.303R}\left(\frac{T_2 - T_1}{T_2 \times T_1}\right)$$

Temperature and pressure are expressed on the absolute scale and R=2. For this calculation one vapor pressure only has to be known for a given temperature, the vapor pressure at T_2 is calculated from the equation. With the vapor pressures for two temperatures the latent heat of vaporization can be calculated. The results are only approximate but they are sufficiently accurate for engineering checks on operation. The graphic method using semi-log paper makes the integration easier to manipulate as the equation

$$\frac{d \log_e P}{d T} = \frac{Q}{RT^2}$$

produces a straight line when the log of the vapor pressure is plotted against the reciprocal of the absolute temperature. Q in the equation is the molal heat of vaporization, R the gas constant=2, P= vapor pressure and T the absolute temperature. In practice it is better to depend upon experimentally determined values where exact data is otherwise unavailable.

VAPOR-LIQUID EQUILIBRIA

It is fortunate that hydrocarbon mixtures do not vary widely from Raoult's law, as this law is used to express the relationship between the partial pressure of a substance in a solution with its mol fraction in the liquid and its vapor pressure in the free state. It is used to compute the volume per cent of a component in the vapor phase in equilibrium with that in the liquid phase.

VAPORIZATION OF ABSORBENT

The vapor pressure of the stripped oil at the temperature of the feed to the column may be used to indicate the amount of oil that will vaporize. The computation may be performed as follows: $P \div \pi = V$ where π is the absolute pressure of fractionation, P is the vapor pressure of the oil at feed temperature and V= volume of vapors given off by oil in cubic feet at temperature of feed. Where steam is used π assumes the value $\pi - P_3$ where P_3 equals equivalent pounds reduction in pressure. The values for pressures at feed temperature can be calculated by use of the Clausius-Claperyron equation where the vapor pressure of the material for one temperature is known together with its heat of vaporization per mol. It may be better read directly from an experimentally determined temperature vapor pressure curve. Let it be assumed for example that fractionator pressure corrected for use of steam, if steam is used, shows the vapor pressure of the lean oil to be 150 mm, at fractionation temperature. The column pressure corrected for steam is two atmospheres or say approximately 30 pounds absolute. What proportion by volume of the vapors evolved will be due to the oil? The calculation is (150x100)÷(30x51.7) =9.67 per cent. Let it be supposed further, for sake of illustration that 2,000,000 cubic feet of vapor results from the absorbed constituents in the oil. Obviously the total vapor evolved will be 2,000,000÷ .9033=2,214,100 cubic feet or 214,100 cubic feet of oil vapor. Now if the mol-pounds of oil circulated in order to produce this volume of gas is known and

the true boiling point distillation is available, the per cent of oil vaporized can be closely approximated. This is done by using a curve where the molecular weight of oil distillate is plotted against the per cent distilled. The procedure for calculating the liquid volume of oil vaporized is as follows: The theoretical volume of vapor that the oil would produce if totally vaporized is found by the formula

$$\frac{W}{M.W.} \times \frac{359 \times T}{492}$$

where W equals total weight of oil circulated; M.W. equals the average molecular weight; 359 is the vapor volume molecular weight constant; T equals absolute temperature in degrees; F equals 460 plus T°F and 492 is 460 plus 32°F. Say 500,000 gallons of lean oil is circulated weighing 7.2 pounds per gallon or 3,600,000 pounds and the average molecular weight is 180. The mol-pounds circulated would be 20,000 or 359x20,000=7,180,000=theoretical vapor volume at 32°F and one atmosphere. But 214,100 cubic feet was vaporized at fractionator temperature which, for illustration, will be taken as 320°F. Then

$$214{,}100 \times \frac{492}{780} = 135{,}048 \text{ cubic feet.}$$

Reduced to 32°F or (135,048x100)÷7,180,000=1.88 per cent approximate. The molecular weight per cent distillation curve is referred to. Say under this per cent the molecular weight of the distillate is found to be 140. The corrected weight per cent would be

$$1.88 \times \frac{140}{180} = 1.46 \text{ per cent,}$$

which is a close approximation. The total oil circulated was 3,600,000 pounds of which 1.46 per cent vaporizes during fractionation 3,600,000 x .0146= 52,560 pounds. This can be converted to liquid measure by estimating the pounds per gallon from the specific gravity of the 1.46 per cent.

ABSORBED REMAINING IN THE OIL

The procedure by which the amount of oil vaporized can be calculated has already been discussed. It is, at least, of equal importance to know what proportion of the absorbed constituents will remain unvaporized in the oil as it comes on the feed plate. Here again, as in absorption, Raoults law is used to predict what will take place. In case an ultimate gas analysis is available for the inlet and exit gases of the absorption step, the nature and percentage of the individual hydrocarbons in the absorbed mixture passing to the fractionator is known. With this information available and the vapor pressure of the oil known together with its mol percentage, the amount of each constituent remaining in the oil can be computed with reasonable certainty. For this purpose equilibrium is assumed to exist between the constituents remaining in the oil and their vapors above it. The individual vapor pressures for the particular hydrocarbons in question are necessary for the calculation, it being assumed that at fractionator temperatures and pressures, the oil is saturated to equilibrium. Neglecting for the moment the vapor pressure due to the oil itself, the calculation is P=px, where P is the vapor pressure of oil saturated to equilibrium, p is the vapor pressure of the pure hydrocarbon at feed plate temperature and x equals the mol fraction in solution of the pure hydrocarbon.

Referring again to the specific example used for purposes of illustration, the fractionator pressure is taken as 30 pounds absolute, the temperature 320°F and the vapor pressure of the oil as 150 mm. or approximately three pounds. It is evident that if equilibrium conditions maintain on the feed plate that the vapor pressure of oil plus the vapor pressures of the constituents remaining in solution is also 30 pounds and that 27 pounds of this must be due to the unvaporized absorbed material. Now if the mol fraction of these hydrocarbons relative to the mol fraction of the oil is known, their total vapor pressure exclusive of the oil can be predicted. The mol fraction of absorbed material in the oil is known from the absorption step, the vapor pressure of the lean oil and the saturated oil at feed plate temperature is available from the temperature vapor pressure curves, or can be calculated, and from these the amount of vaporization that will take place can be determined with a fair degree of accuracy. Fortunately the mol ratios of absorbed to absorbent is easily determined for it is from this that the degree of vaporization can be predicted. Let it be assumed that there are 5000 mols of absorbed and 20,000 mols of absorbent, or 20 per cent molar saturation. The vapor pressure of the saturated oil at feed plate temperature for this example is taken as 203 pounds and the lean vapor pressure as 3 pounds (203—3)÷.2= 1000 pounds, which is the vapor pressure of the combined absorbed material at fractionator pressure exclusive of oil. What mol per cent of this 1000 pounds vapor pressure mixture will give the oil on the feed plate a vapor pressure of 30 pounds the oil vapor pressure itself being three pounds. The equation is

$$\frac{\pi - P_a}{P_2} =$$

per cent unvaporized, where π= fractionator pressure P_a= Vapor pressure of absorbent at fractionator pressure and P_2= vapor pressure of absorbed components at fractionator pressure. In the specific example given, the calculation is

$$\frac{(30-3) \times 100}{1000} = 2.7 \text{ per cent.}$$

Digressing for a moment at this point; the vapor pressure of the oil or cooling to absorption tempera-

(Continued on page 144)

Some

By F. L. KALLAM[1]
and
L. J. COULTHURST[2]

THE need for removal of solid and liquid particles from gas-streams is brought about either from an economic standpoint or from the aspect of possible injury to human beings. When we take cognizance of the vast number of industries depending upon this type of separation in some phase of their operations, the importance of the solution is readily recognized. It is regrettable that this problem, along with so many others, does not lend itself to easy mathematical treatment because this allows the success of the analysis to depend almost wholly upon the skill and judgment of the designer.

SEPARATION PROBLEM

Before discussing certain theoretical considerations which should be taken into account in the design of separators in general, it would be well to look at the separation problems as found in our own natural gasoline industry. Here the purpose is to separate from the natural gas to be processed in the absorber all of the entrained crude oil, naphtha, sand and water in what is generally termed a "wet gas scrubber." The detrimental effect of crude oil and water in the absorption medium is well understood and needs no further elaboration here.

The second demand for a scrubber arises in the case of the

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[2] Chemical Engineer, Petroleum Research and Development Department, Southwestern Engineering Corporation, Los Angeles.

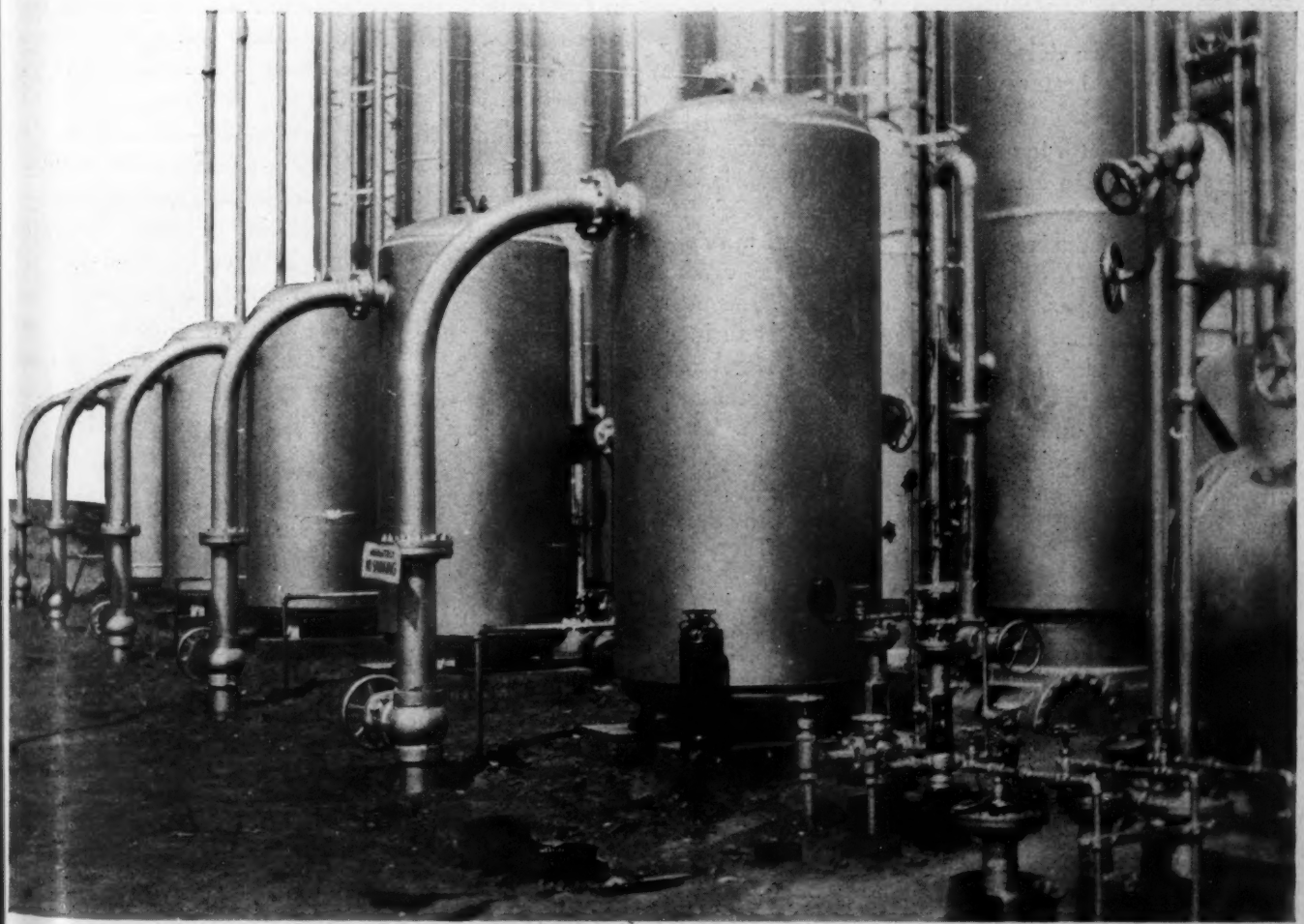
Theoretical Considerations For the Design of Separators

processed gas leaving the plant where it is necessary and economic to remove and recover from this gas-stream all of the entrained absorption oil carried over from the absorber. The device for accomplishing this work is known as the "dry gas scrubber."

It is necessary in some plants, particularly the older ones, to remove entrained absorption oil from the finished gasoline vapor stream as it leaves the fractionating column and before it reaches the condenser. Failure to do this robs the operator of control over the color and end-point of his product, and the device for making this particular separation has become known in the industry as a "mist-extractor."

In addition to these separators there are the usual steam separators on the lines to the still and prime-movers. Where exhaust steam from reciprocating pumps is used for reduction purposes in the still, a separator is vital for the removal of both lubricating oil and moisture.

A late innovation is the use of separators between plates in the fractionating and rectifying columns. These are located directly underneath each plate and prevent fine spray from the tray beneath being mechanically carried by the rising vapors onto the plate inself. Fractionation should not be impaired by mechanical carry-over as is so often the case, and



neither should color trouble be experienced when using these plate separators.

No two plants will be found to contain the same design of separator. It is axiomatic that where practice is so diversified theory is not understood. This fact has led to the present survey of the subject of separators with the hope that knowledge gained in other industries can be profitably employed toward correcting the separator failures in our own industry.

SEPARATION OF MATERIALS

In order to separate any two materials it is necessary to find some particular property in relation to which these two individual substances differ. Generally speaking the properties commonly utilized in separation are:

(1) Unit size, (2) Electrical conductivity, (3) Specific gravity (true or apparent), (4) Magnetism, (5) Solubility, (6) Viscosity, (7) Surface tension, (8) Vapor pressure.

PROPERTIES OF AEROSOLS

First it must be recognized that when separators are placed before and after an absorber these devices must deal with aerosols. An aerosol is a disperse, or "colloidal," system in which a solid or liquid is dispersed in a highly subdivided condition in a gas. Strictly speaking this should apply to highly dispersed systems, as clouds, mists and smokes, but it may, in a larger sense, be made to include coarser systems as fine dusts and sprays. Therefore it is necessary that we delve into the properties of aerosols in order to better understand how to properly deal with them.

A study of matter in a colloidal state convinces one that its behavior in a finely divided condition is decidedly changed from its normal conduct. For instance, the total surface area per unit mass is enormously enlarged. A one-inch cube has a total surface of six square inches. If we disperse this cube into 1,000,000 small cubes each 0.01 inch the total surface has been increased to 600 square inches. Now this means that more of the total molecules are actually at the surface and none of them very far from it. This brings the substance into more intimate contact with any other phase, whether solid, liquid, or gas, that may be introduced into the space between these particles.

CHEMICAL ACTIVITY

It might be well to point out that a substance in suspension, as just outlined, is a relatively large volume of gas enables it to exert its chemical and physical activity to a maximum. In this connection we cannot pass up the opportunity to again call attention to this fact as being the reason why a great degree of absorption takes place in an absorber between the trays, or where the oil is in the form of an extremely fine mist or fog. This is in direct variance with the view that the absorption takes place in the body of oil upon the trays. That the chemical activity of a substance is greatly increased by dispersing it into a gas is well illustrated in the case of coal dust in air. When this mixture is suitably ignited it will burn with an explosive violence comparable to the explosion of a gas mixture.

When a substance is disintegrated into a dust, its electrical capacity is enormously increased, particularly if it be dust that is dispersed into a gas system. Since any charge of electricity will reside upon the surface of a substance, increasing the surface will proportionally increase the electrical capacity. Thus the numerous particles become charged electrically through direct absorption of ions from the gas itself or by contact with some suitable solid or liquid surface. For example, when falling raindrops are flattened and ruptured by the resistance of the air, they become positively charged, while the surrounding air becomes negatively charged.

Another characteristic of finely divided particles is the increased buoyancy when suspended either in gases or liquids. If, for example, a particle under the influence of gravity settles through a gas it is impelled by a force which is proportional to the cube of its radius. This motion is opposed by a second force which is in turn proportional to the radius and the velocity of the particle. In dealing with very small particles these forces are practically equal with the result that the body settles at an extremely slow rate. In fact, conditions are sometimes such that the two forces exactly balance each other, and this results in the particle being driven about in the gas in Brownian motion. Smokes exhibit this phenomena.

The rate of settling of particles less than 10^{-3}cm. in diameter is so slow that it is hopeless to obtain effective settling of such particles from gases in motion. Fortunately, the natural gasoline industry is not interested in separation of particles of from 10^{-3} to in diameter such as make up clouds, or those of from 10^{-5}cm. in diameter such as make up clouds, or those of from 10^{-5} to 10^{-7} as are found in smokes. The rates at which spherical particles of unit density will settle in still air are compared in the following table:

TABLE NO. 1

Diameter of Particle, cm.	Rate of Settling Cm/sec.	Meters/hr.
10^{-2}	30	1080
10^{-3}	0.3	10.8
10^{-4}	0.003	10.8 cm/hr.
10^{-5}	0.00003	1.08 mm/hr.

Obviously, only particles larger than 10^{-3} cm. diameter can be removed effectively by a strictly settling process, and even in such cases the practical difficulty of maintaining large volumes of gas in a sufficiently low quiescent state is readily apparent.

The tendency for these small particles in a gas

to combine with each other to form appreciably larger particles is more or less resisted because of the tendency on the part of the particles to absorb the gas. It is far more difficult for such particles to coalesce when their surfaces are covered by a film of absorbed gas. This condition may be likened to a cushioning effect of a gas-layer which prevents the particles themselves from coming into actual surface contact. The result of this inefficient contact is that the aerosol is extremely stable. Under suitable conditions of concentration, electrical charge and temperature, however, the aerosol becomes flocculated. This is evidenced by the formation of soot upon the internal surface of a flue.

The character of the gas-flow is also an important item in the separation of particles from a gas stream and the form of flow is greatly influenced by the density and viscosity of the fluid. If the velocity is high there is present turbulent flow which causes eddies and side-currents which throw the particles about such that settlement is impossible. Below the critical velocity the gas moves in straight-line streams parallel to the direction of flow, making it practical to attempt settlement of the entrained particles. If the particles are small and the difference in density between them and the gas is comparatively low, then the path of the particles leaving the gas-stream will be on a long gradual slope.

If the particles are large and their relative density to that of the gas is high, the use of high momentum of the particles against the lower resistance of the gas will be useful in separation. The momentum of the particles in the gas depends upon their mass and velocity, which in turn depends upon the impact of the gas and the time it has been acting. Consequently if the gas is speeded-up for a short distance the particles do not have time to acquire much momentum, but if the time element is increased and the speeding-up done slowly, the velocity of the particles approach that of the gas. Under these conditions the impacts between the gas and the particles diminish and the stored-up momentum within the latter approaches a limit. The time required to approach this limit depends upon the density of the particles and the viscosity of the gas. Thus by delivering gas containing undesirable oil particles into a chamber with an initial high velocity followed by a sudden change in the direction of flow, at which point the gas velocity is vastly decreased, fair separation of the particles from the gas should result.

The stability of an aerosol is determined by the rate at which the particles diffuse or settle. When the particles of a dispersed system come into contact with the walls of the containing vessel they tend to adhere to the surface, or to each other, and so are eliminated from the system. The efficiency of such a scheme, however, is very low. It can be raised by agitating the gas, which results in a greater number of contacts per unit of time, or by increasing the contact surface. Consequently if a porous filtering medium made of cotton, glass-wool, or steel shavings were employed, the gas would be broken-up into numerous small streams or eddy-currents. Thus the gas would be brought into contact with a relatively enormous surface to which the particles could adhere, therefore vastly increasing the diffusion rate. In this connection the particles, particularly the larger ones, are forced or enmeshed in the contact surface by centrifugal force resulting from the eddy-currents set up in the gas in passing through the contact surface.

EFFECT OF TEMPERATURE

The temperature of the gas stream influences the separation of the particles in various ways. First it affects the density of both the particles and the gas which directly modifies the effect of gravity tending to settle the particles from the gas stream. The higher the temperature the less this force will be. Secondly, this downward force is resisted by the viscous friction of the gas which increased with temperature, tending also to prevent settling of the particles. Practically all commercial gases carry vapors which can be condensed, at least to some extent, by lowering the gas temperature, Such condensation reduces the gas volume which means a lower gas velocity, together with an increase in mass concentration of the non-gaseous particles. The condensed vapor also tends to penetrate the gas film surrounding the particles, thereby enlarging the diameter of the individual particles and tending to make them adhere to one another more readily. This is easily understood when it is realized that the surface tension for the liquid non-gaseous particles is higher at the lower temperatures. Obviously, low gas temperatures promote better separation for particles from a gas-stream.

Pressure reduces the volume of the gas, thus increasing the concentration of the entrained particles per unit of volume. While increasing the pressure does not effect the viscosity of a gas, it does increase the condensing of condensable vapors which may be present, thus having an effect similar to that gained by lowering the gas temperature. The greatest effect due to increased pressure, however, is the fact that the gas density itself is materially increased, which lessens the effect of gravity on each particle, thus tending to prevent settling. For instance, in raising the pressure from atmospheric to 300 pounds on an oil-gas separator, the proportional densities of the oil and gas change from approximately 880/1 to 41/1. The difficulty of removing particles from gas may be said to be greatly increased as the pressure of separation is raised.

SEPARATOR DESIGN

Having discussed at some length the characteristics of aerosols we can now make certain statements regarding entrainment of non-gaseous particles in a

gas stream. First, it may be concluded that entrainment will increase as:

1—The diameter of the particles decrease,

2—The difference in density between the particles and the gas decreases,

3—The viscosity of the gas increases.

Since none of these factors are controllable, and since the size of the particles is unknown, and the gas-stream is not at rest, it follows that no calculations may be made which will be helpful to the separator designer. In lieu of this condition it is necessary to deal in generalities and be content with a resume of deductions made from the discussion on aerosols.

(1)—When the particles to be removed from a gas are smaller than 10^{-3}cm. in diameter it is impossible to remove them from the system by settling means alone. Somewhat better results can be obtained by the use of contact surface. Where the particles exceed this diameter, however, the entrainment can be diminished by the settling method, provided the gas velocity is kept below the critical point, or in streamline flow. Such separators must be designed with a long chamber which will permit of a considerable time factor for the removal.

(2)—The common fallacy that an entrainment separator must slow down the gas velocity should be avoided in all cases where contact surface is employed. The directly opposite view should be taken because of the benefits to be derived due to eddy-currents set up within the surface which tend to throw the particles into the enmeshing surface.

(3)—Where contact surface is employed it must be of such nature that once the liquid particles are contacted they cannot again drip off into the high-velocity vapor stream. Where this precaution is not observed the particles are re-picked up by the gas, making the separator useless.

(4)—Good separation can be had with a gas carrying large particles if the traveling direction of flow is suddenly changed. The vapors will be more easily deflected than the particles. Because of the latter's momentum they will not pass around a corner, and if means are provided for the coalescing of the particles at this point, the gas will not be able to pick them up again. Moving the mixture of gas and particles around a sharp corner, properly provided with enmeshing surface, will give excellent results.

(5)—Separation of the particles from a gas can be accomplished by utilizing centrifugal action, such as gained by the insertion of twisters in a separator which produce a whirling motion in the mixture. The greater mass of the entrained particles causes them to be thrown out of the gas stream itself. From the expression for centrifugal force it is evident that the diameter of the twisters must be as small as possible in order to gain the maximum force for removing the particles from the gas.

(6)—Attempts at removing entrained particles from a gas-stream will meet with no success in cases where chemical or physical action takes place between the particles and the various constituents of the gas. Failure at coalescing gas-cushioned oil particles, for example, by means of an oil-spray is analogous to the notoriously impossible feat of washing soot from a chimney-wall through the use of a water-spray.

(7)—Regardless of the scheme of separation employed the temperature of the gas-stream should be as low as can be economically obtained on a commercial scale.

(8)—For the most efficient separation of particles from a gas-stream the operating pressure should be such as to result in the greatest difference in densities between the gas and the non-gaseous particles.

(9)—The separation of entrained particles from a gas-stream should be accomplished with the least expenditure of energy in the form of pressure-drop.

WET GAS SCRUBBERS

The ordinary wet gas to a gasoline plant contains condensable hydrocarbons, crude oil and solid matter such as sand and shale. In addition, the gas is generally saturated with water vapor. All of these substances should be removed from the gas-stream, and inasmuch as such particles are of material size, the problem is not so severe as the case of the dry-gas from the plant which contains a fine absorption oil mist. The failure of most wet-gas scrubbers is that they operate upon the centrifugal-force principle. The gas is introduced tangentially into a vessel, with the idea that the heavy particles will be thrown out of the gas, cling to the side-wall and eventually drip to the bottom where they are manually removed. The scrubbed gas is removed from the top of the scrubber. Due to the fact that large volumes of gas must be treated per day, of the order of millions of cubic feet, the scrubbers are built in large diameters, which gives the gas-whirl a radius of possibly two to three feet. From the following equation:

$$F = \frac{MV^2}{R}$$

where F = centrifugal force
M = mass
V = velocity
R = radius

It is apparent that the force available for throwing or ridding the gas of the entrained particles will be small. Possibly the reason for the size of this type of scrubber is the desire to keep the pressure drop low. In any event, considerable better separation will be obtained if the gas-stream were broken up into numerous streams where the radius of the whirls could be materially reduced.

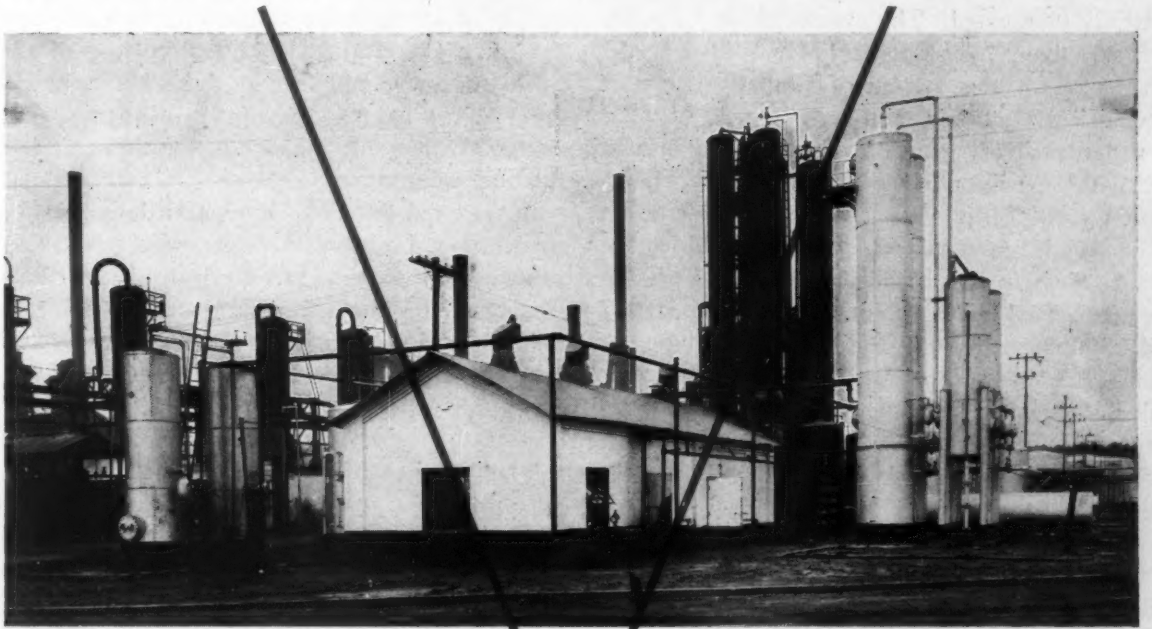
A second feature needed in this type of scrubber is provision made for removing the separated material from the action of the gas. These particles are left on the sides of the vessel exposed to the gas-stream velocity. If most scrubbers of this type are checked

(*Continued on page 104*)

Degasification of Pressure Plant Products

By GEORGE REID
Associate Editor

DURING the past two years much study has been given the problem of degasification of pressure distillate and many refiners have erected so-called debutanizing units for the stabilization of their cracking unit products. Most of this work has been done with the view of removing the propane and butane, especially the former, from pressure distillate just as it leaves the cracking unit accumulator vessels and prior to chemical treatment. Such installations have proven effective in lowering losses incurred in storing and acid treating pressure distillate, and further handling.



In contradistinction to such practices, Simms Oil Company, at its Dallas, Texas, plant has gone a step further in the development of such degasification systems. Admitting the necessity of stabilizing pressure products and recognizing the advantageous features of previous systems the operators were, however, not convinced of the necessity of stabilizing the pressure distillate, then acid treating this material, to be followed by redistillation and subsequent chemical treatment of the rerun cracked gasoline. It seemed more advantageous to fractionate cracked gasoline direct from the cracking units in bubble towers, combine this gasoline with cracked gasoline from the tube still or topping units, and then stabilize or debutanize the gasolines from these two sources blended together.

Under the direction of Fred N. Williams, general superintendent, Simms Oil Company's refinery has been completely remodeled and reconditioned during the past year and a distinctly new method of operation adopted insofar as this plant is concerned. The results secured and the changes and improvements involved will be the basis of a future article. For purposes of this discussion however, it is necessary to state that all virgin gasoline in the Healdton crude being processed is removed through preheating in exchanger equipment before the crude reaches the pipe stills. In the pipe stills a cracking effect is maintained to produce a yield of about seven per cent of cracked gasoline.

Vaporization in these units is carried down to a heavy fuel oil which is later run to coke in regulation coking stills of the shell type. Gas oil thus produced is charged to the Cross cracking units which are operated to produce gasoline, recycle stock, a small amount of coke,

and Cross plant fuel oil. This method of operation, including the operation of the absorption and stabilizing plant working in conjunction with the topping and cracking system, secures a yield of 60 to 62 per cent of gasoline from Healdton crude.

Gases from the operation of the skimming operation, the tube still cracking and the Cross cracking operation, as well as the coking stills, are chemically washed, and processed through an absorption plant equipped with a reabsorption system. Gasoline from the Cross cracking units and the fraction of cracked gasoline secured from the tube stills, is blended together and processed through the degasification plant, stabilized and separated into a light and heavy fraction. The light fraction is mixed with the product of the absorption system and this blend is taken through a final stabilizer, where it is rendered propane free and stable. It is then employed as a blending medium.

Through this type of installation the initial boiling point of the finished gasoline is controlled to the extent that vapor losses in storage transferring and loading are practically eliminated. The system is very flexible and very selective. According to Mr. Williams, the chief advantages of this system of vapor recovery or vapor saving lies in its selectability. "The old installation or vapor recovery plant involved a complicated system of gathering lines and was delicate in its operation. It did not recover all vapors subject to evaporation and the material recovered was wild and subject to evaporation unless further stabilized. With the present control of the initial boiling point and the first part of the distillation curve of all gasoline produced in the plant the losses in storage are virtually eliminated. Under this system of handling the problem, we are getting all of the measurable and returnable actual volume of products from the plant operation and have cut evaporation losses throughout," he stated. It is reported that six to seven per cent of propane is removed from the cracked gasoline produced. The plant "makes and saves" 230 barrels of gasoline daily and this volume is represented by the light fraction of gasoline removed from the bottom of the final stabilizing column.

GAS WASHING DEVICES

In discussing the mechanical construction and the operating features of this modern installation it is necessary to present the details in the order as presented in the flow chart of the system, handling the gas through its chemical clarification and through the absorption plant before going into the details of the primary and final stabilization system. The figures having to do with pressures, temperatures, volumes, and dimensions of equipment in this writing are taken from the flow chart inasmuch as they accurately interpret the conditions for which the units were designed.

The gas washing equipment was designed to remove hydrogen sulphide from about 46,000 cubic feet per hour of gases derived from the Cross cracking units and the tube stills, and about 29,000 cubic feet per hour of gases derived from the skimming and coking departments of the refinery. These gases are washed separately in duplicate units employing sodium hydroxide as the neutralizing agent. Each unit of the system consists of one water washing chamber, 5 x 30 feet in dimensions and one caustic washing tower 4 x 15 feet in size. The caustic and water draw off lines from all four chambers enter a common header line which conveys this material of water separator from which the spent solution drains into the sewer. Any gasoline condensed in the washing operation overflows from the separator to a point near the base of the scrubber where a pump discharges it into the side of the distillation column of the absorption plant.

After washing, the gases from the coking and topping units passes into the compression plant where its pressure is raised to about 30 pounds — this being the operating pressure of the absorber. After compression it is passed through an after-cooler and into the side of a scrubber which is provided with a series of baffles. This scrubber also acts as an accumulator for the collection of any gasoline condensing as a consequence of the compression and subsequent cooling of the gases. Such gasoline combines with that gasoline coming from the water separator previously mentioned and is discharged with it into the side of the absorption plant distillation column.

Gases from the Cross units and the pipe still are not compressed, but flow through the two washing drums receiving the water wash and subsequent caustic wash leaving the top of the second tower through a four-inch uninsulated line to meet the flow of gases from the compression-scrubber operation and mingle with them.

ABSORPTION SYSTEM

This mixture of gases is conducted through a mist extractor, 2 x 6 feet in dimensions, from which it passes through a Foxboro flow meter into the bottom of the absorber. The absorber contains 18 bubble trays spaced 20 inches apart and is four feet in diameter. Dry gas leaves the top of the absorber through a Neilan-Schumacher back pressure valve and enters the fuel distributing line. A safety pop valve is provided at the absorber top which will vent to a field gas burner, or disposing system. Other gases fed to the absorber are derived in small quantities from the top of the cracked gasoline feed tank supplying the stabilizer through a vent line and also through a vent line leading to the absorber from the top of the rich absorption oil surge or supply tank.

Lean absorption oil is charged to the absorber from a 6 x 12-foot tank, vented to the air, and provided with sight-gauge glasses, and b.s. and water draw-off. The absorption oil is about 38° A. P. I. gravity with a 390 initial boiling point and 460 end point. The oil is charged through a three-inch line by a motor driven centrifugal pump to the top of the main absorber where a Foxboro flow-meter controls the volume taken off at this point and permits about 450 gallons per hour to

pass onward and into the re-absorber system. The oil is circulated through the primary absorber at the rate of 100 gallons per 1000 cubic feet of gas treated.

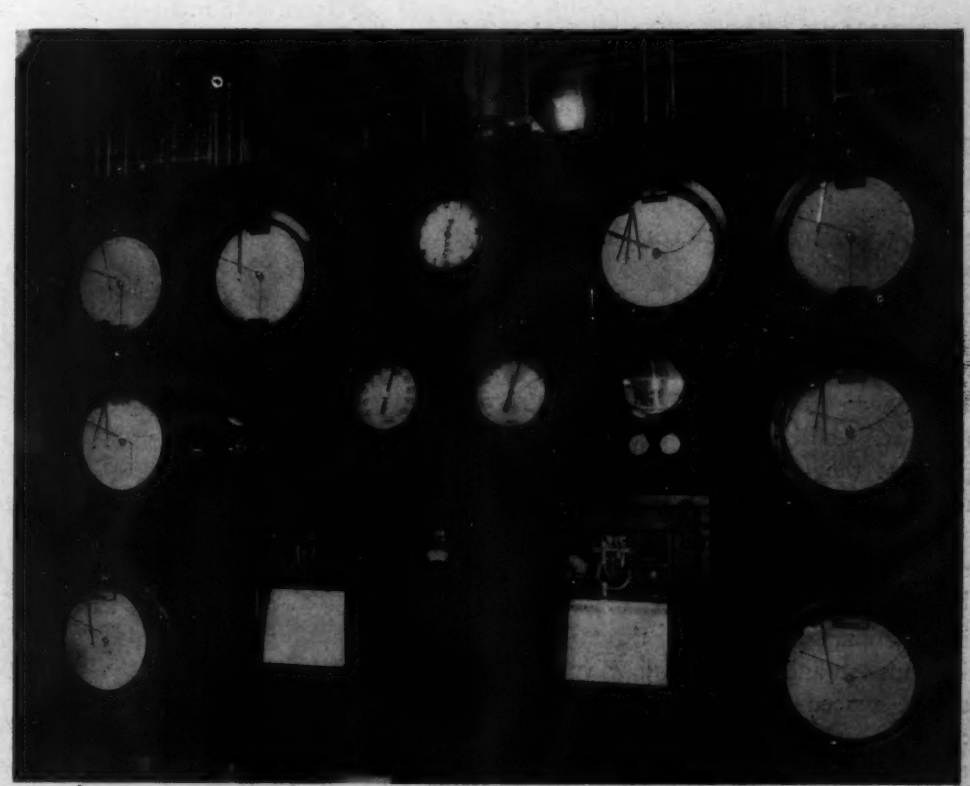
Enriched absorption oil accumulates in a second 6 x 12-foot surge tank through a six-inch line leading from the bottom of the absorber. A one-half-inch vent line is provided from this vessel to vent entrained vapors back into the absorber. This accumulator is also used for the accumulation of enriched absorption oil from the bottom of the re-absorber which flows into the rich oil tank through a one-inch line. A centrifugal pump with four-inch intake and three-inch discharge line discharges the rich absorption oil at about 100°F. through the exchanger, preheater system and into the still. Leaving the exchanger the oil has been increased in tempearture to 260°F., and passes into the preheater equipment where the temperature is further increased by use of steam to 320°F. Oil inlet to the still may be through either the fifth or seventh bubble deck from the bottom. Exchanger and preheater equipment is insulated with 1½ inches magnesia, and one-fourth-inch asbestos cement. The still column and other insulated towers in this lay-out are insulated in the same manner but with the addition of one-fourth-inch Portland cement.

The still employed is of the kettle type with the kettle placed at one side near the bottom of the column and is 6 x 12 feet in dimensions. The kettle is provided with a two-inch closed steam coil of a total of 450 square feet of heating surface. Open steam is used through a flow-meter on a 1½-inch line and injected below the liquid level in the kettle. Steam at 150 pounds gauge is employed and at 366°F. The still column is three feet 5½ inches inside diameter and is provided with 18 bubble decks placed 20 inches apart. Top steam is provided in this column to maintain 170°F. temperature. Also two water legs are installed working on the second and fourth bubble deck from the top of the column.

Rich oil flows downward through the still to flow from the bottom through a four-inch insulated gooseneck liquid seal over-flow line and into the kettle through a cross-pipe type distributor. This kettle is held at 335°F. and vapors are vented back into the distilling rectifying column through a three-inch insulated vapor line. A Foxboro recording temperature controller maintains a constant temperature at the top of the column.

The denuded lean oil passes from the bottom of the kettle through a four-inch insulated line at 335°F. through the heat exchanger where it is cooled to about 175°F. It then passes through a water cooled exchanger where its temperature is reduced to 90°F. A Neilan-Schumacher liquid level controller works from the outlet side of the water cooler. From this point the lean oil is conducted to the top of the lean oil accumulator tank for recirculation back through the absorption system.

Vapors from the top of the still column pass through a four-inch line and through a water cooled condenser section where they are cooled from 165°F to 135°F. and this effects the condensation of refluxing material to be recirculated back into the top of the still column, entering at the top bubble deck. The reflux trap is 4 x 6 feet in dimensions. An overflow line is provided to conduct any surplus reflux material not needed for refluxing, over into the main gasoline accumulator tank. Re-



This efficient control board governs operation of the degasification unit at Simms Oil Company's refinery at Dallas, Texas.

flux is returned to the still by means of a simplex pump and through a two-inch line with a reflux ratio of 2: 1. Vapors from the reflux trap pass through a second water cooled condenser, then through a final condenser where the cold gases from the top of the final stabilizer are employed as cooling medium. This is termed a "propane cooler." The gasoline is now condensed and enters the main gasoline accumulator tank at a temperature of about 85°F.

This accumulator tank is also the collecting vessel for a light stream of gasoline removed from the cracked gasoline in the primary stabilization which will be described later. This light gasoline, however, carries with it some light uncondensed vapors, just as does the absorption gasoline accumulating in this 6 x 12-foot drum. It is at this point that the two systems of absorption and stabilization are tied together. The light vapors from each of the two gasolines blended in the main accumulator are conducted through a 1½-inch line into the bottom of the re-absorber. This column is two feet in diameter and is packed with 12 bubble decks placed 20 inches apart, and operates at 50 pounds pressure with a bottom temperature of 105°F. and a top temperature of 90°F. A safety pop valve is provided at the top releasing into the field burner line previously mentioned. Rich oil from the bottom of the reabsorber flows by gravity into the main or primary rich oil surge tank as previously described and from there to the still. Stripped gases pass out at the top through a back pressure control valve into the fuel line.

PRIMARY STABILIZER OPERATION

Gasoline from the Cross cracking units and the tube still which also produce cracked gasoline is blended together and charged to the stabilizing or degasification plant. The blended stocks accumulate in a charging tank, 6 x 12 feet in dimensions, which is vented to conduct any wilder gases through a one-inch line to the absorption system.

A simplex pump working under control of a Foxboro flow controller discharges the unstable gasoline at 90°F. through a two-inch line to the heat exchange equipment where the temperature is raised to 240°F. by exchange with finished stable gasoline leaving the kettle. At this temperature the charged gasoline passed through the preheater where temperature is raised to 270°F. and at this temperature it enters the fractionating column at either the fifth, eighth or eleventh bubble decks from the bottom.

The fractionating column is three feet 5½ inches in inside diameter and is equipped with 20 bubble decks. These are spaced 24 inches apart below the eleventh deck and 20 inches apart above the eleventh bubble deck. Sample drain lines and thermometer wells are provided for each of the 20 bubble decks. The top head of the tower is removable for installing bubble decks. The column is operated at 50 pounds pressure.

Gasoline entering about the middle of the column at 270°F. is partially vaporized. The liquid portion flows downward over the trays and passes out of the column through a two-inch insulated line, U-type to control liquid level, and into the top of the kettle through a distributor of the cross pipe type. Closed steam at 140 pounds pressure and 360°F. is used as the heating medium with temperature controlled by a Foxboro controller, to hold the kettle or reboiler temperature at 310°F. Distilled vapors are vented back into the fractionating column through a four-inch insulated line which enters the column near the lowest bubble deck.

The stable gasoline is derived from the bottom of the kettle, where level is controlled in the usual manner. This product passes through the exchanger at 310°F. and is cooled to 160°F. at this point. It is further cooled to 95°F. or whatever temperature is desirable, in a water cooled condenser. The initial boiling point of this product, and therefore the temperatures used in the operation of the stabilizer, is governed by the needs or wishes of the operators, and may be raised or lowered at will. This is true of all temperatures and pressures recorded in this writing, where they are given simply as an example of one type of operation instead of arbitrary figures.

The top of the tower is held at 120°F. by means of refluxing. Vapors from the column are conducted through a two-inch line to a primary condenser. This line is also provided with a pressure relief valve as a safety measure, venting to the field burner. The change in temperature of vapors or gasoline in the condenser is from 120°F. to 100°F., at which temperature it enters the side of a reflux-accumulator drum 3 x 8 feet in dimensions. A liquid level control governs the overflow of gasoline from this tank, permitting it to flow over to the main absorption plant accumulator which ties the two systems together as previously described. Reflux is returned to the main stabilizer through a one-inch line entering the column just above the top bubble deck. Vapors from the top of the reflux-accumulator tank pass through a back pressure control valve and through a one-inch line to the main absorber system.

FINAL DEBUTANIZATION

The discussion so far brings the system to the combination of absorption gasoline and light gasoline from the primary stabilization column in the main accumulater tank. This vessel is vented to the re-absorption system previously described which extracts any remaining gasoline from the lighter vapors and gases entrained in the two light products blended at this point.

From the bottom of the light gasoline accumulator drum the blended gasoline passes through a 1½-inch line to a flow-controlled simplex pump which discharges through a one-inch line to heat exchanger fa-

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And we have a staff of more than 100 technologists whose sole duty it is to help you make these profits They are your consulting staff Their personal success depends on increasing your success and they usually succeed

No guessing about patents either The license contract you sign for the Dubbs process guarantees you complete immunity from patent troubles

All charging stocks look alike to a Dubbs cracking unit Therefore, use the stock you most want to get rid of, whether fuel oil, gas oil or kerosene, and change about from one to the other as often as you like

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor

cilities consisting of one exchanger and one preheater where the temperature is raised to 225°F. The hot gasoline may be fed into the tower at the sixth, eighth, tenth, twelfth or fourteenth bubble decks from the bottom.

The final stabilizer operates at high pressure and the design calls for 215 pounds gauge. The column is two feet in diameter and is provided with 24 bubble decks 24 inches apart, and one distilling tray at a point near the bottom. Temperature at the bottom is controlled by controlling steam which is used in a closed coil in the bottom of the column. The temperature is held at 290°F. The top of this column is also provided with a pressure release pop valve as a safety measure on the line where the vapors pass outward to the reflux trap and accumulator. Vapors pass through a two-inch line to a water cooled condenser and into the top of the reflux trap. This drum is 2½ x 8 feet in dimensions. A simplex pump charges reflux material to the top bubble deck of the fractionating column through a one-inch line. The fixed gases leaving the accumulator-reflux tank pass through a second condenser, through a back pressure control valve, and through the propane cooler previously mentioned in connection with the condensation of absorption plant gasoline. From this point the vapors are conducted to the fuel lines and taken to the refinery furnaces and consumed.

In the bottom of the final stabilizer column the finishing stable light gasoline fraction is accumulated to be removed under control by a throttling type liquid level controller. This product at a temperature of about 290°F. passes first through the heat exchanger where its temperature is reduced to about 155-160°F. It then passes through a water cooled condenser section and is reduced to a temperature of 90°F. This condenser is equipped with steel tubes, as are a few others in the system which are employed for similar work, but for the most part the preheater, condenser and exchanger equipment is provided with Admiralty tubes.

This finished grade of light gasoline which is produced at the rate of 230 barrels per day is ideal blending stock and its preparation has greatly reduced the purchase of natural gasoline for blending purposes . It has a gravity of 90° A.P.I. and a recovery specification of 90 to 92 per cent, with initial boiling point to suit the needs of the operators of the plant, which is usually held sufficiently high to effect a material reduction in evaporation losses.

From the final cooling facilities the finished light grade of gasoline is taken direct to a continuous treating system, sweetened and transferred to storage. The heavier grade of stable gasoline taken from the primary stabilizer is acid treated, using the centrifugal contact method, and neutralized with alkaline contact clay. This treatment calls for four pounds of 64 gravity acid, which is immediately centrifuged to cut down polymerization. It is then neutralized with 3½ pounds of 200 mesh clay and one-third pound of lime per barrel, and the slurry pumped to Sweetland presses. There is no further treatment.

Engineers differ in their opinions as to the type of debutanizing units which shall be used and practically all previous material published deals with the subject of degasification of the whole fraction of pressure distillate as it comes from the cracking unit, with subsequent acid treatment, redistillation and doctor treatment of the finished gasoline. G. A. Burrell and R. P. Mase, before the Western Petroleum Refiners Association, (November, 1929, page 77, REFINER AND NATURAL GASOLINE MANUFACTURER) discussed the general application of several high and low pressure types of degasifying installations in use at several refineries, and their work has proven of much value. The installation at Dallas, however, marks the first opportunity to discuss a system employed for the debutanizing of cracked gasoline from various units in combination with the production of absorption gasoline.

The writer is indebted to the Simms Oil Company and Fred N. Williams, general superintendent, and O. Mingus, plant superintendent, for permission to present the mechanical construction and operation features of this modern installation in such great detail.

Some Theoretical Considerations for the Design of Separators

(*Continued from page 96*)

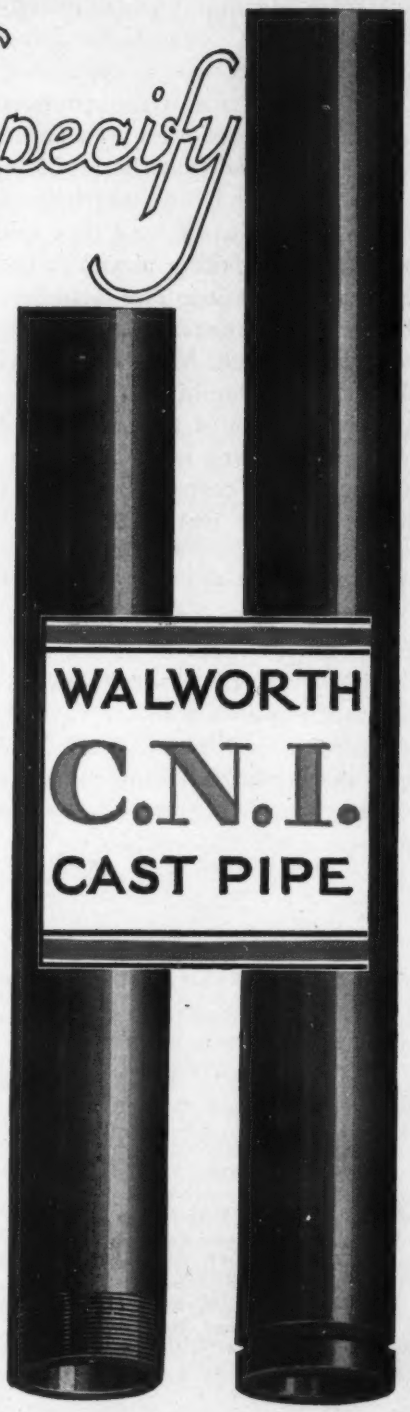
for gas velocity past these walls it will be found that it is surprisingly high, and of such magnitude that it can again pick-up the once separated material. The remedy here is of course to provide a louver-like interior wall, which will allow the gas to throw the particles into this enmeshing surface when the condensate can drain to the bottom out of contact with the whirling gas.

The second general type of inlet scrubber is that employing impact. Generally the gas is introduced into the scrubber vessel through a nozzle, and after losing its velocity is removed from the top. Occasionally the gas is introduced horizontally, but in most cases it is projected downward, although in some installations it has been found to be projected upward. In this latter case the gas was removed from near the bottom of the scrubber, and needless to say the separation was extremely poor. Most of these scrubbers, however, would have a fair chance of functioning if proper precautions were taken for keeping the separated material out of the gas stream.

The two types of scrubbers already discussed are the best types found in practice, there being literally thousands of other devices all the way from boiler-shells with the tubes removed to scrubbers with

A 19 foot span of C. N. I. Pipe will support a load of more than 4,000 pounds

Specify



● Strength tests on C. N. I. (Chrome-Nickel-Iron) threaded Pipe are regularly made as a production routine. ● In order to test full size sections of C. N. I. Pipe for transverse breaking strength, the testing equipment supports the pipe on 19-foot centers and the load is applied at the center of the span.

7 men deflected this 30-ft. span of C. N. I. couple pipe 19 inches without affecting it

for OIL

● Tested in this manner C. N. I. Pipe shows an arbitration bar transverse strength approximating 4200 pounds.

● C. N. I. metal can be depended upon to show a tensile strength of not less than 30,000 pounds per sq. in.

● C. N. I. Pipe is regularly made up in 5-foot lengths or in two or more welded lengths. ● Available in 1½"-2"-2½"-3"-4"-5"-6" and 8" sizes—threaded for screwed coupling or grooved for Victaulic coupling.

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countless baffles arranged to the fancy of the designer. Generally the designer was a foreman assisted by a welder. From a survey of the separation to be made it would seem, however, that the impact and centrifugal type would well answer the purpose, assuming of course that they are properly arranged for the conditions at hand. The material to be separated is generally of such size that elaborate enmeshing surface is not necessary, besides, such surface is not adaptable to crude-oil service.

DRY GAS SCRUBBERS

When considering the dry-gas scrubber it is a different story, since the material to be removed here is of very small magnitude. Yet a survey of the industry will reveal that the same type of scrubber is used for this service as is used on the wet gas. Obviously, such devices recover very little of the misted absorption oil, so that the conclusion is reached, that no oil is being lost from the absorber. Were it possible to actually determine the amount of daily absorption oil make-up lost through this means in the average plant, the figure for oil topped into the finished gasoline would be greatly reduced.

The nature of the dry-gas scrubber demands that it be of a type possessing efficient enmeshing surface. This surface should be of simple design, which means correct design, and aside from offering surface for the minute oil particles to cling to, will also provide means for taking these same particles out of the gas flow. Besides the metal surface particularly designed for the purpose, numerous types of metal lath, steel shavings, etc., have been used. Along this same line sponges, steel-wool, glass-wool, excelsior, etc., have been tried, and while in some cases found satisfactory, the general tendency is for these finely divided surfaces to plug-up and pack, which resulted in increasing pressure drops.

What has been said of the dry-gas scrubber will apply to the plate-separators and mist-extractors, as the problem here again is the removal of very minute particles. This can best be done by specifically designed enmeshing surface rather than by any haphazard make-shift material.

STEAM SEPARATORS

Regarding steam-separators, only a mention can be made, since there are several hundred different types on the market, together with probably twice as many more patents on similar devices. Very excellent results have been obtained with both the impact and centrifugal types of separators, to say nothing of the contact surface type employing high velocities. The better separators are all designed so that the removed condensate can not again be picked up by the steam. It is evident that the removal of water and heavy lubricating oil from steam is a much simpler and easier problem than the separations already discussed. Consequently, because a separator proves satisfactory on steam service is no criterion that it can be used on gas and absorption oil separation.

In closing, it is cautioned that the problem of separation in a gasoline plant is one which should have the best minds of the industry, and that aside from the separation angle itself, other phases of the design should also have consideration. The scrubbers should be built with the idea of renewing the interiors, and should not be welded closed. Where corrosive conditions exist the material should be selected with this end in view, and all types of flimsy easily deteriorated surfaces avoided. Even in fields which are not recognized as necessarily corrosive the fact that the gas contains considerable water-vapor will lead to rusting out of the interiors. The surface should be selected with the idea of not plugging with either crude oil or sand and provision should be made possible for the convenient removal of these materials. Thought should be given those scrubbers used ahead of compressors, such as in a refinery vapor-recovery plant, where there is possible damage to life and property due to the separator filling completely with liquid. Automatic types of alarms or removal systems in these cases are indispensable.

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Method of Determining Gasoline Production Costs

By R. E. KERFOOT
Cost Accountant

ACCORDING to information published by the United States Bureau of Mines, there was produced by all methods, in the United States, during March, 1930, a total of 37,190,000 barrels of gasoline, as follows:

54 per cent Straight run .....20,043,000 barrels
36 per cent Cracked .....13,494,000 barrels
10 per cent Natural gasoline ... 3,653,000 barrels

and, excluding the quantity of natural gasoline produced, 40 per cent of the balance was produced by cracking processes alone. Of all the gasoline produced by cracking, nearly 25 per cent, or three and one-half million barrels, was produced in Texas.

A further observation of gasoline production statistics, brings out the fact that the yield in production is increasing, and also, that the quantity produced by cracking processes, is on the increase. This is, of course, due to higher operating efficiency, and the larger use of cracking processes for certain types of crude oils, which, if handled by any other method, would produce little, if any, marketable gasoline.

A very great deal has been written and published on refinery production costs, all of which, I am sure, has been quite constructive and enlightening. Much of it has been from the viewpoint of the office accountant, and although in its first thought, intended to be simple, is somewhat complicated and ramified for the average operator to thoroughly understand its completeness. There can not be any set rule by which all refinery costs may be figured, as every installation, every crude oil and every process, requires different treatment and consideration.

Some operators go into a vaster amount of detail than others, in arriving at their production or manufacturing costs, each one feeling that his method is the best as adapted to his own individual requirements.

There are, however, some very essential facts that every refiner should know constantly, and if he is operating on the budget basis, is in a very good position to control his costs.

The most essential facts are the fixed or direct operating expenses, consisting of labor, chemicals used, royalties, repairs and maintenance of the plant—stills, boiler plant, treating plant, agitators, pumps, etc. In normal efficient operating periods, there will be only slight and consistent fluctuation in these items.

VARIABLE OPERATING EXPENSES

The next items of importance, are the indirect or variable operating expenses, or Works General Expense, consisting mainly of

Superintendence and Clerical
Power
Fuel
Water
Laboratory
Compensation Insurance
Automobile and Truck
Plant General Repairs

Some of these items tend to fluctuate, perhaps more than the fixed or direct operating expenses, but the superintendent should be held accountable, as he is in direct control of the operations and has his own budget data as a definite guide for performance.

If the operating and accounting departments will thoroughly assist one another, a most accurate result may be had and complete control of costs be evidenced.

Operators have been known, however, who displayed the extreme lack of intelligence and judgment, by insisting that the cost data furnished by the accounting department was in error, because it did not happen to conform with their "idea" as to what they thought it should be. But, the information upon which the costs were founded, was furnished by the operator, so it was quite evident that full co-operation did not exist, due to the fact that the operator actually believed that his "guess" method was correct, and his unwillingness to be advised in cost accounting fundamentals.

As it is true that each plant presents a different problem, just as different executives desire certain data that appeals to them and would not be of interest to others, so do cost methods vary. The most satisfactory method is one of greatest simplicity, yet containing sufficient detail to reflect the true facts.

In presenting the following method, proven to be

ample in its scope to provide intelligent and definite results for cracking process plants, its simplicity has caused no sacrifice of essential facts. This method is here applied to a cracking plant, using a type of crude oil producing a good yield of gasoline, with a fuel oil residue. Some of the gasoline produced, is aided in meeting special requirements by blending with natural gasoline. The entire plant has been considered as one operation, but the subsidiary expense ledgers have been so arranged as to make segregation of various operations, such as cracking cost, treating cost, rerunning cost, etc., quite easy if that data be required. The chart of accounts governing is so coded that this analysis may readily be made on all vouchers.

Crude oil inventory is valued at the actual cost delivered into storage tanks, including base price, premium paid, pipe line handling charge, freight, switching, unloading, etc. The value of the crude oil consumed in operations during the month is arrived at by taking an average of the price of beginning inventory, plus current purchases, less price of closing inventory.

Recycle oil is valued at the same price as crude oil. In the matter of yield and costs, no consideration is given to the quantity of recycle oil run to stills, nor the quantity produced therefrom, but only the difference between the beginning and closing inventory of this product is taken into the Production Costs and Yield report. In normal operations over a period of time, the fluctuation in the inventory quantity of this oil is consistent.

Fuel oil herein, is treated strictly as a by-product and the quantity produced during the month is priced at the value per barrel of Fuel Oil Sales, during the month. Beginning and closing inventories are also valued on this basis. Accordingly, as this is a by-product, the value of the quantity produced is deducted from all operating costs, the remainder being the cost of gasoline produced.

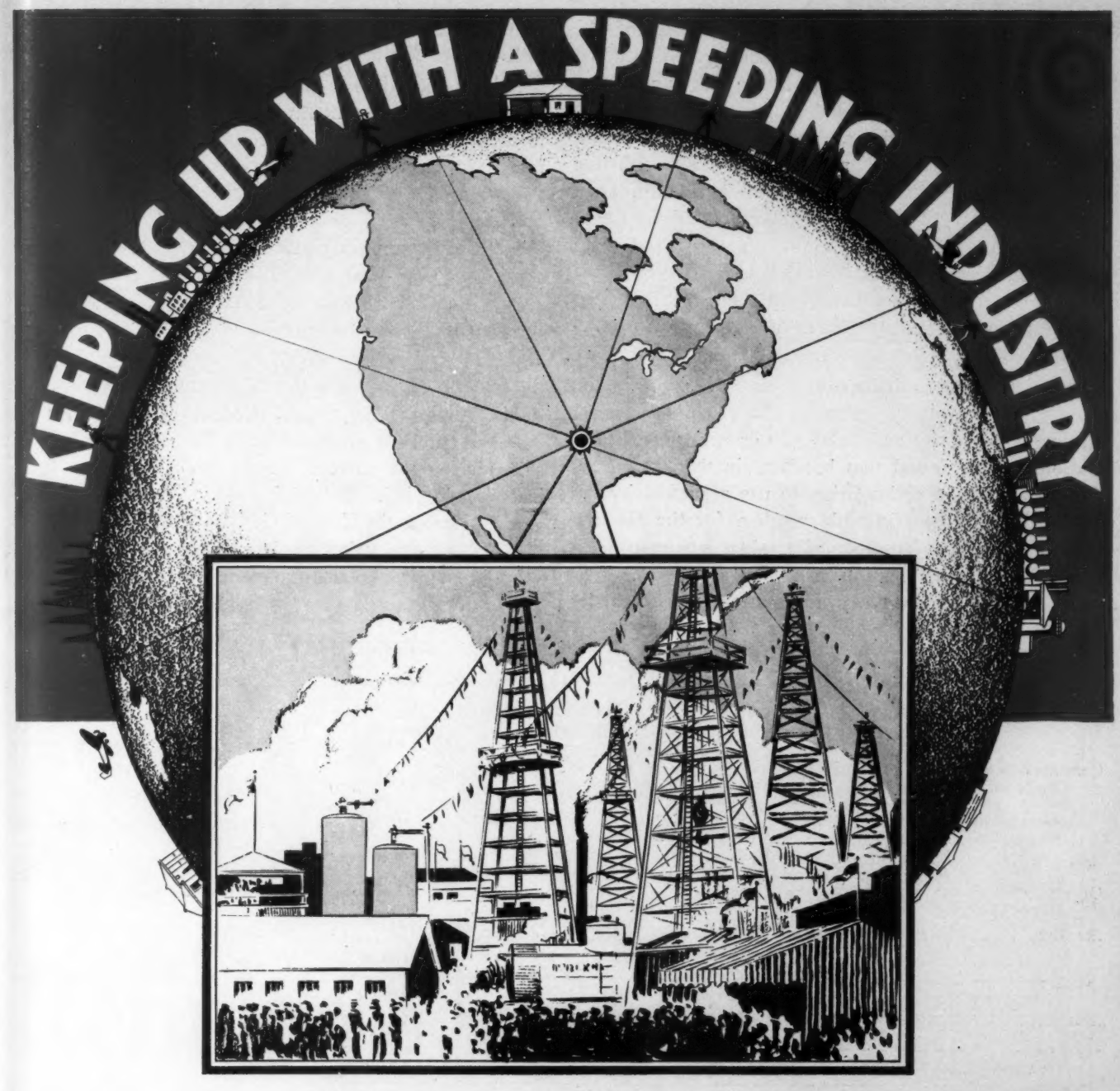
Gasoline beginning inventory is valued at the price of the previous month's closing. To this is added the total cost of gasoline produced, as shown on Schedule II.

For statistical and proof purposes, Summary of Operations, Schedule I, is prepared. First is the be-

SUMMARY OF OPERATIONS. Schedule I

	CRUDE OIL			RECYCLE OIL			FUEL OIL		
	Barrels	Unit Price	Amount	Barrels	Unit Price	Amount	Barrels	Unit Price	Amount
Beginning Inventory	50,000	$1.50	$75,000.00	3000	$1.50	$4,500.00	500	$0.90	$450.00
Receipts—Purchases	25,000	1.50	37,500.00	....	....	.....	....	..	.....
Receipts—Produced	.....	...	.....	....	...	.....	8540	.90	7,686.00
TOTAL	75,000	1.50	112,500.00	3000	1.50	4,500.00	9040	.90	8,136.00
Consumed in Operations	30,000	1.50	45,000.00	500	1.50	750.00	....	..	.....
Sold (Cost of Sales)	1,000	1.50	1,500.00	...	...	.....	9000	.90	8,100.00
Closing Inventory	44,000	1.50	66,000.00	2500	1.50	3,750.00	40	.90	36.00
TOTAL	75,000	1.50	$112,500.00	3000	1.50	4,500.00	9040	.90	$8136.00

	FINISHED GASOLINE			NATURAL GASOLINE			Devised by R. E. Kerfoot
	Barrels	Unit Price	Amount	Barrels	Unit Price	Amount	
Beginning Inventory	500	$2.52	$1,260.00	150	$3.36	$504.00	
Receipts—Purchases	...	....	.....	380	3.25	1,235.00	
Receipts—Produced	19,825	2.38	47,234.00	...	...	.....	
TOTAL	20,325	2.38+	48,494.00	530	3.28	1,739.00	
Consumed in Operations	.....	....	.....	450	3.28	1,476.60	
Sold (Cost of Sales)	20,000	2.38+	47,720.50	...	...	.....	
Closing Inventory	325	2.38+	773.50	80	3.28	262.40	
TOTAL	20,325	....	$48,494.00	530	....	$1,739.00	



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ginning inventory, as per the ledger accounts of the various products. Second, is the quantity and value of all oils purchased, taken also from the ledger accounts. In proof of this, an independent record is maintained of all oils unloaded during the month, as per plant daily unloading reports, which must tally with the quantities charged into the ledger for the month. Then follows the charges to inventory accounts, of the quantities produced from operations, as per Production Costs and Yield Report, Schedule II. The sum of these three items represents the quantity and value of all oil to be accounted for at the plant during the month.

From this total is deducted the sum of oils sold, and the Closing Inventory (actual), the remainder representing the quantity and value of oils consumed in operations. It is found that handling in this manner is less intricate than endeavoring to use a summarization of the daily changes in tank gauging, for the fluctuation of quantity is automatically taken into consideration directly, rather than by means of an operating expense account of inventory adjustment. As the daily yield and daily gaugings are closely observed, there is little chance for error.

Briefly, Schedule I gives a true picture of changes in stocks during the month, as purchases are verified as mentioned, production is accounted for by data contained in Schedule II, quantities sold are compared and verified with sales invoice register, and the closing inventory is actual, as per gauging.

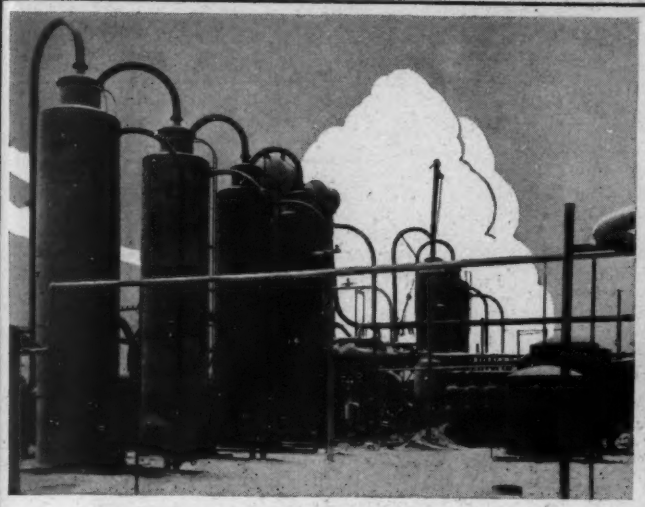
Now for the main feature; the answer to the many times asked question, "how much does it cost?"

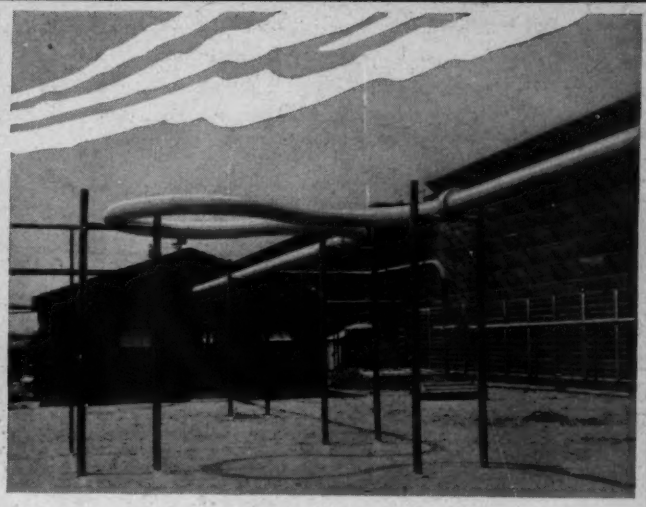
The answer contains, as per Schedule II, the quantity and value of oils consumed in operations, and the amount of operating expenses, segregated as between direct and indirect charges. The sum of these three items represents the "Total Production Cost." As the value of fuel oil produced is at the value of fuel oil sales during the current month, this amount, or "realizable value," is deducted from "Total Production Cost"—leaving the Cost of Gasoline Produced ($0.0566 per gallon). No value is placed upon "Loss in Refining," but whatever amount it may be, is automatically

(*Continued on page 150*)

PRODUCTION COSTS and YIELD. Schedule II

	Per Cent	Barrels	Unit Price	Amount	Total	
Consumed in Operations:						
Crude Oil	98.35	30,000	$1.50	$45,000.00		
Recycle Oil	1.65	500	1.50	750.00		
	100.	30,500		45,750.00	$45,750.00	
Operating Expenses:						
Direct Charges:						
Labor				1,900.00		
Chemicals				750.00		
Repairs & Maintenance				550.00		
Royalty				1,500.00		
Other				100.00	4,800.00	
Indirect Charges:						
Superintendence & Clerical				800.00		
Power				1,400.00		
Fuel				1,200.00		
Water				175.00		
Laboratory				80.00		
Compensation Insurance				175.00		
Automobile & Truck				90.00		
General Plant Repairs				450.00	4,370.00	
Total Operating Expenses					9,170.00	
Total Production Cost					54,920.00	
Produced:						
Gasoline	65.	19,825	2.38	47,234.00		($0.0566 Per Gallon)
Fuel Oil	28.	8,540	.90	7,686.00		
Loss in Refining	7.	2,135	....	.....		
	100.	30,500	....	54,920.00	$54,920.00	Devised by R. E. Kerfoot





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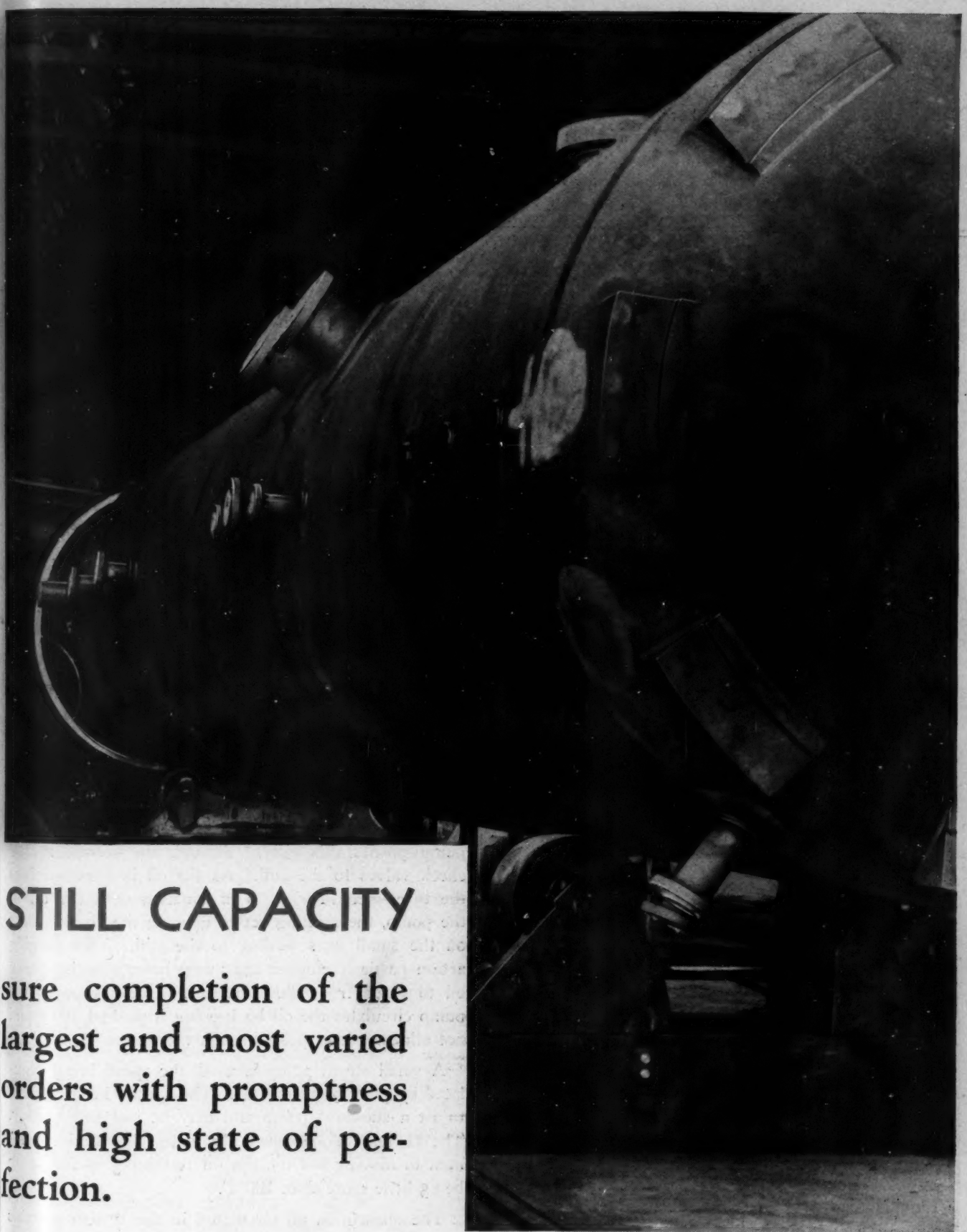

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(*Continued from page 85*)

material for refluxing of the kerosene section of the tower. This practice simplifies the reflux problem to a great extent and all reflux material is taken out of the system before it reaches the run-down tanks. Thus only permanently finished products are gauged in the working storage. The water legs are provided with water draw-off valves at the bottom, and with gauge glasses to indicate the water level along the sides of the containers. Small Chippewa pumps, electrically driven, are employed for refluxing which are controlled by Brown temperature regulating instruments. Regulation of volume of oil over the towers is secured by control of liquid flow by means of a by-pass line on the discharge side of the pump which circulates excess liquid back into the suction side, rather than controlling the speed of the pump.

The unit as a whole is very flexible and satisfactory efficiencies are secured when operating within the capacity range for which it was designed — 6000 to 9000 barrels per day. In addition much closer fractionation of the various cuts is secured, and these streams, due to careful control of temperatures, require routine checking but one daily. Control is aided by means of Brown Steam Flow Controllers regulating the superheated steam used in the flash chambers. Further economy is found in the fact that the present kerosene fraction is very closely fractionated and does not require redistillation.

CORROSIVE SUBSTANCES NEUTRALIZED

Two means are employed to combat corrosion of equipment at this plant. It was found that the heavier fractions from the second bubble tower bear non-corrosive materials, but the lighter stream of gasoline vapors taken off of the first bubble tower carry some hydrogen sulphide. To counteract the acidity of this gas a small amount of ammonia is injected into the vapor lines leading from each of these towers on the two units. A drum of ammonia, 150 pounds, is used about every five days. At the point where the ammonia leaves the drum the company engineers have fitted up a sight indicator which shows the ammonia bubbling through a glass gauge and a small container. The flow is controlled by means of needle valves at the drum and above the indicating device. The ammonia bubbles through a small quantity of kerosene, and in this manner the operator may be sure that the reagent is leaving the drum enroute to the vapor line. The usual pressure gauge is also provided to indicate the pressure of ammonia remaining in the drum.

Soda ash solution of about 10 degrees Beaume is injected into the crude oil at the pump which discharges it into the tube still. Very small amounts are required to effect complete neutralization and materially retard corrosion to equipment. A soda ash solution mixing plant was erected near the distillation unit. This plant consists of a storage house, mixing pump, and three solution tanks. The soda ash is mechanically dumped into a larger tank into water. The mixture is then pumped from the conical tank bottom and circulated back into the same tank until the proper solution is secured. From the mixing tank, when the ash is thoroughly dissolved, the solution is transferred into two smaller tanks adjacent to the mixing vat. These tanks also have conical bottoms which lend to ease of cleaning. From these tanks, one for each distillation unit, the soda ash solution is taken to the crude oil charging pumps and injected into the discharge line.

Approximately every 60 days each of the large tube still distillation units are shut-down for a short period for a thorough inspection and cleaning. Through this practice the equipment is kept in an excellent state of repair, as all of the auxiliary equipment, as well as the retort and fractionating devices, are minutely inspected and such repairs or adjustments made as needed.

Absorption Oil Cleaning Plant

(*Continued from page 87*)

When the oil from the vaporizer is admitted through the first set of check valves, the surging action of the pump pushes this excess through the second set of check valves to the still. As the oil is admitted into the three-inch lines, it is in common with the oil in the pump, the pushing action opening the check valves on the small lines leading to the still. This surging action partially empties the pump lines, allowing more oil to enter from the vaporizer. Oddly enough, the pump circulates the oil by keeping it pushed away and not allowing it to pass through the valves.

A small steam pump is used, the speed being regulated by plant requirements. The special head is made to fit a standard pump and may be installed quickly. The cooling arrangement eliminates the trouble common to moving hot oil, the oil remaining in the pump being little more than 100°F.

The absorption oil circulated in the system remains water white and retains a high percentage of its original efficiency. The efficiency of one plant was increased by about eight per cent through the installation of a cleaning plant. Erected at a small cost, the system soon pays for the original installation through outright saving of oil and increased plant efficiency.

Team Work Gets Cracking Units Back on Stream

A BONUS system backed by pride of achievement on the part of the men has enabled Ashland Refining Company, Ashland, Kentucky, to hang a record of 10 hours and 55 minutes clean-out time, from stream to stream in the operation of its Dubbs cracking installation. The clean-out cost with the bonus system in effect is almost exactly the same per month as was formerly experienced while the time saved has resulted in an increase in through-put of four to five thousand barrels per month, for the unit equipped with a 10 x 40-foot reaction chamber operating non-residuum runs. The story is one of collective efforts, sustained interest in the work, and contribution of ideas, as well as one dealing with the mechanics of cleaning a cracking unit and getting it back in operation.

IN discussing the record for clean-out time or stream to stream time, achieved by the clean-out crew at the refinery of the Ashland Refining Company with F. W. Irwin, general superintendent, he stressed the fact that the bonus is not alone responsible for the records made by the crew. "There is," he stated, "one important factor which can not be shown in figures, is the real reason for the great improvement, and that is that our cracking plant superintendent, Palmer C. Talbutt, has been able to get his clean-out foreman, clean-out crew and plant operators all interested in cleaning out the unit in the shorest possible time. With this accomplished every man from the top to the bottom has furnished ideas and suggestions which have led to clipping off a few minutes here and there.

"Further, a large amount of the credit for our reduced clean-out time is due to our clean-out foreman, Mr. Herbert French. He not only has furnished many ideas which have resulted in the saving of ten minutes here and thirty minutes there, but he has the happy faculty of being able to work, not only with superiors, but with the men under him, and such factors as these, after all, have a great deal to do with our present clean-out records."

The clean-out operation when operating non-residuum is as follows: The clean-out crew is composed of a clean-out foreman, 12 clean-out men and two truck drivers. The truck drivers are used while pulling the cable, the coke falling directly into the trucks. When the cable is out of the chamber one of the truck drivers is released and the other is used until the chamber walls have been scaled. In other words the truck drivers are used for the transportation of the coke from the reaction chamber to the coke pile.

When the plant is shut down the clean-out foreman and two tube men start to work. These men hot-bolt the top and bottom heads of the chamber and start running furnace tubes. When the two tube men finish cleaning tubes and replacing the plugs they are allowed to leave.

The main body of the clean-out crew starts to work when the water is drained from the chamber. While seven men are dropping the bottom head of the chamber the others are getting the tools ready, oiling hoists, and the like.

While the cable is being pulled the men are placed as follows: Two men cleaning furnace tubes; two men on the cable hoist; two men on the vapor and transfer line; two men dumping the trucks; clean-out foreman and four men at the bottom of the manhole. The men signal the men on the hoist by means of an air whistle and keep the coke cleaned up and the manhole opens by means of punching bars. When the cable is out of the chamber the two hoist men adjust the air motor at the top of the chamber and lower a single cable to which an umbrella type elevator is attached into the chamber.

The men are usually through running the vapor and transfer lines by this time and they assist in scaling coke from the chamber walls. The men divide into two shifts of four each and scale the chamber walls with picks.

REPLACING CABLE

With the chamber cleaned of coke, seven men are placed on the elevator to hang the cable on the lugs. One man stays in the bottom of the chamber to help pull the cable inside, and two men pull the cable up to the manhole on the outside. The wires on which the cable is hung are made up before cleaning time, cut to proper lengths and the tie wires attached. This eliminates any lost motion in the chamber since it is only necessary to tie the wires to hooks on the chamber wall.

With the cable hung, two men put up the residuum line, three men tighten up the top chamber head, and six men raise the bottom manhead and bolt it tight.

During the clean-out the operators and firemen clean and inspect all pressure release valves on the plant, safety valves; take care of thermo wells and see to any other minor repairs.

Twenty hours was set for a fair stream to stream time and the bonus paid to clean-out men is based on that schedule. The men are paid 60 cents per hour and if a fifteen-hour stream to stream time is made the men receive pay for the number of hours they work plus a five-hour bonus, the five hours being the difference between 15 and 20 hours stream to stream. The clean-out foreman is paid 75 cents per hour.

It has been determined lately that in cases where the reaction chamber is not too hot that better time can be made in scaling the walls by having six men on the elevator. These men go into the chamber at the top to avoid any coke falling on them and use coal miners' picks in scaling the walls as the elevator is slowly lowered. They scale the entire chamber before coming out. Two other men then enter the chamber as soon as these men have completed their work and drill out any oil level lines which may be plugged with coke.

MAKING READY

In order to make quick stream to stream time the number of hours required to get the plant ready for the clean-out crew after the fires are out, and the number of hours required to get the unit back on stream, have to be held as low as possible. In shutting down the unit the operator has the chamber as dry as possible at this time. The raw oil pump is stopped, fires are extinguished, the operator pumps the reflux leg dry, closes the suction valve on the hot oil pump and stops this pump. He then starts draining the tubes while the fireman goes to the top of the chamber and closes the hand wheel on the check valve to the transfer line and the suction of the hot oil pump. The surge lines of the hot oil pump are drained.

During this time the operator is releasing the pressure on the reaction chamber. Steam is cut into the chamber as soon as the pressure is released and the chamber is steamed 30 to 45 minutes from the bottom. Water is started slowly into the bottom of the chamber as soon as the steam valve is closed. This water is injected into the chamber by means of a 10 x 5 x 10-inch McGowan water pump, and is discharged into the chamber until the temperature at the top drops down to about 200°F. Since the water pump has been installed to force water into the chamber to cool it, the cooling time alone has been cut down from four and five hours to two and two and one-half hours. In addition it has saved time by having a cooler chamber for the men to work in.

Formerly in putting the unit back on stream very light fires were used while charging the system, in order to keep from depositing coke in the tubes, but the

(*Continued on page* 154)

These men have succeeded in establishing a record for short time clean-out periods, and have set up a mark of 10 *hours,* 55 *minutes from stream to stream for the Dubbs cracking unit operated at Ashland, Kentucky, by the Ashland Refining Company. Reading left to right, back row, Palmer C. Talbutt, cracking plant superintendent; Herbert French, clean-out foreman; Harold Rucker, D. Cochrane, L. Davis, fireman; Tom Brown, operator. Center row, Albert White, Wade Hale, Henry Shockey, Lafe Grubb, George Slone and Bulger Nichols. Bottom row, Zeph Osborne, Pliney Bishop, Ira Johnson, T. P. Bayless and Bob Friley, assistant clean-out foreman. Photograph through courtesy of F. W. Irwin, general superintendent*

Chemical Treatment of Petroleum Distillates

IV. Sulphuric Acid

By L. J. CATLIN
Chief Chemist, The Standard Oil Company (Kansas)

THE various terms used in describing different strengths of sulphuric acid may be better understood by considering briefly the chemistry of its manufacture. The starting point is the oxidation, or burning, of sulphur. In ordinary combustion sulphur units with two atoms of oxygen to form sulphur dioxide, SO_2. By using catalysts this oxidation may be carried one step farther forming SO_3. When SO_3 is passed into water they unite according to the formula H_2O plus $SO_3 = H_2SO_4$. Starting with an excess of water the percentage of H_2SO_4 is increased as more and more SO_3 molecules are added until finally every molecule of H_2O has united with the SO_3, and the solution is 100 per cent H_2SO_4. Sulphur trioxide being a gas, is soluble in the liquid sulphuric acid, and more may still be added beyond the 100 per cent point. This is called fuming sulphuric acid, or oleum, and is sometimes expressed in percentages higher than 100 per cent. The most commonly used acid for refining purposes contains 93.2 per cent H_2SO_4, and has a specific gravity of 1.84, or 66 Be. on the heavy scale. It is also called oil of vitriol.

Speaking chemically, we are interested in sulphuric acid reactions principally along two lines, viz: its reactions with the different hydrocarbon groups previously considered; and its action on the sulphur compounds. Speaking in terms of specifications these reactions have to do with color, stability with respect to gum formation, and sulphur content. First consider the hydrocarbons.

Paraffins.—The definition of this term leads us to expect little, if any reaction with treating reagents, and this is true with respect to sulphuric acid of ordinary strength, and under ordinary conditions. By using fuming acid, or elevated temperatures, all members of the paraffin series except methane, may be made to react with the acid, but this is beyond the scope of refining practice.

Olefins, or Unsaturated Hydrocarbons.—From the standpoint of chemical control of the sulphuric acid reaction, this group commands chief attention. Coming into a position of importance with the advent of cracking, the unsaturates were for many years looked upon as a necessary evil and the only view of acid treatment was the question of eliminating them with as little acid as possible, in order to keep down treating costs. At present, with their proven value as knock inhibitors, the chief concern in treatment is to preserve them as much as may be consistent with production of stability against gum formation, and in some cases perhaps color and odor of the finished gasoline. Loss of volume and value of gasoline, outweighs the question of cost of treating material. Luckily in this case, increased volume and value come from decreased cost of treatment as a general rule.

As previously stated, the mono-olefines are not considered particularly offensive. The di-olefines, and especially the conjugated di-olefines are the ones to be eliminated. The relative amount of reaction in these sub-groups is governed by at least four factors under the control of the plant operator, viz: amount of acid per barrel of distillate; strength of acid; time for reaction; and temperature of reaction. From general considerations we know that increasing reactions come with increasing ratios of acid to oil, increasing strength of acid, increasing time and higher temperatures; but the particular combination to use in a particular case will involve a great many side issues. With so many variables, it is obvious that similar results may be attained in a great many different ways. Much will depend upon the final disposition of the acid used. If acid is to be recovered from the sludge it will not be possible to do as much refining with a given amount of acid each time through as in a case where the acid is discarded or burned.

ACTION OF ACID ON OLEFINES

Two types of action of sulphuric acid on olefines are generally recognized. In the first case the SO_4 from the acid enters into combination with the hydrocarbon, forming what are known as alkyl sulphuric acids, represented as $RHSO_4$, and neutral esters, R_2SO_4. These are partly removed in sludge and partly dissolved in the oil. The first of these, being acid in nature, may be neutralized by caustic or washed out of the oil with water, but the other, being neutral is not so easily

removed in this manner. Either one is, however, detrimental in the oil as they decompose, or hydrolize with moisture back to H_2SO_4, giving the oil an acid reaction, and also renewing the action of acid with the oil, with its attendant formation of sludge and heavy polymers. These of course cause the oil to go off color. Acid treated distillates are usually rerun with steam alone or with fire and steam, which completely removes the combined acid radicals which have been introduced mainly by the action of sulphuric acid on the olefines. The acid thus removed is corrosive to stills and condensers and it is therefore important to remove as much of it as possible by washing and caustic treatment. Excessive treatment with acid is to be avoided both on this account and on account of losses of valuable products, while on the other hand acid treatment in too small amounts tends to the formation of the neutral esters in the place of the mono-alkyl esters of the $RHSO_4$ type, and these neutral esters are more difficult to wash out or neutralize with caustic.

The other type of reaction with sulphuric acid is termed polymerization. In this the acid acts more in the nature of a catalyst, causing the reaction to take place without entering into the composition of the resultant product. Another term used more or less interchangeably with polymerization, is the term condensation. In the sense in which the latter is here used it is a chemical term, and does not in any way refer to its use in the physical sense where it describes the change from a vapor state to a liquid. Without attempting a technical definition, we may say in general that polymerization, or condensation, means a reaction the opposite of cracking. It is the combination of small molecules to form a heavier molecule. It does not presume that it is an exact reversal of the cracking reaction since it does not result in an oil identical with that from which the cracked product was produced. Polymerization products may be dissolved in the acid, or rendered sufficiently heavy to settle out of the lighter distillate, thus causing actual loss in volume; or they may remain dissolved in the distillate but be converted to a boiling point beyond the gasoline range, thus representing a final loss in finished gasoline after rerunning. Since acid in this reaction acts as a catalyst it means that it merely hastens a reaction which would take place anyway, but at a rate that would probably permit use of the gasoline before causing serious trouble.

TREATMENT AT LOW TEMPERATURE

The nature of the reaction of sulphuric acid on the olefines is of course dependent upon the same four variables already mentioned. A method of treatment at low temperatures has been devised, based on the fact that the solvent action of sulphuric acid takes place without polymerization at temperatures below 32°F. This low temperature action is said to be sufficient to remove the diolefines without undue action on the more desirable mono-olefines. The use of acid of a strength around 83 per cent or lower is for a similar reason. Acid of lower strength may be used by increasing the time or the ratio of acid such as is accomplished by recirculating sludge, but sludge inclusion losses become higher with lower strength of acid. With fuming acid, oxidation takes place in addition to the formation of the alkyl sulphates. This leads to gum formation in the treated oil in addition to extraction of unduly large portion of desirable products. Fuming acid is used only when it is necessary for reduction of sulphur content. After treating with fuming acid it may be necessary to follow with acid of lower strength in order to remove by solution some of the compounds formed by the fuming acid.

The naphthenes are little affected by ordinary acid treatment. With acid of strength around 96 per cent or higher the lower fractions are converted to sulfoderivatives of benzenes, which by steam distillation yield benzenes, that is aromatics.

The aromatics are little affected by acid of lower strength. The minimum strength for their solution is probably between 92 and 95 per cent. With higher strength and fuming acids these are converted to sulphonic acids which are broken down by steam distillation if they remain in the distillate, yielding sulphuric acid and the benzene or polymers of a tar-like nature.

Gum. Gum formation in cracked distillates is similar to polymerization except that it probably starts by oxidation of unstable hydrocarbons by oxygen from the air or as in the case of fuming acid treatment, from the SO_3 breaking down to SO_2 and O. Polymerization follows this oxidation and the product eventually becomes insoluble in the oil, settling as a varnish-like material.

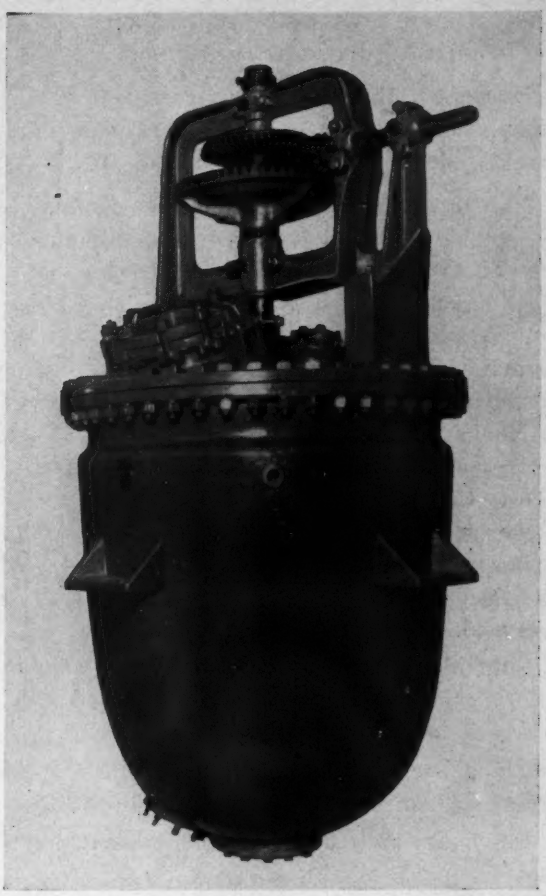
Several investigators have shown that gum-formation in finished gasoline starts with oxidation, and Voorhees and Eisinger have shown that the reaction is auto-catalytic, having an induction period during which the reaction is relatively slow till a certain condition is reached, when it speeds up rapidly, and from this point on there is not a great deal of difference in different gasolines. The important difference being in the length of the induction period. Sulphuric acid reduces the tendency of a gasoline toward gum-formation by removing the compounds which are most easily oxidized. Hence the losses incurred by a reasonable amount of acid treatment are simply losses which would be incurred later by oxidation if the gasoline were held in storage for a prolonged period, and in the latter case they would cause motor grief in addition.

SULPHUR REMOVAL

Sulphuric acid may be used to reduce the sulphur content of distillates where the amount is above the percentage allowed in finished products. This treatment, however, is so drastic that it is never used unless necessary. If it is used on cracked distillates it entails high losses of valuable hydrocarbons. In a rather extensive

MODERN GREASE MAKING

requires specialized equipment

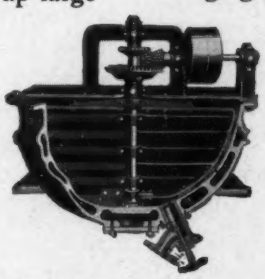


300-gallon Dopp "D" Double Motion Pressure Mixer, arranged for chain drive. Two sets of paddles revolving in opposite directions at different speeds give uniform saponification and the scrapers shorten time of heating, also cooling when desired.

SOME of the largest manufacturers of lime base grease are making larger profits on grease production as a result of careful analysis of time and cost factors.

They have found that it does not pay to tie up large grease kettles for "one-batch-per-day" production, when a small additional investment in modern pressure mixers enables them to double the output from their present kettles.

Where the pressure process of saponification is being used Dopp pressure mixing equipment cuts production costs. The cast-in-one-piece construction safeguards against steam leaks. Quick heating, also quick cooling when desired, are made possible because with the "D" mixer the jacketed surface of the Dopp kettle is scraped clean at each revolution of the agitator. There are no seams, joints, welds, rivets or bolts to provide lodging places for material.



Cross section of Dopp Seamless Jacketed Kettle with "D" Double Motion Scraping type Mixer and outlet closing flush with inside.

Concerns desiring to investigate the possibilities of pressure saponification for their bases or to secure data on process and equipment are invited to use the facilities of our completely equipped Experimental Department at Buffalo. Write for Circular 63, a technical discussion on the making of Lime Soap Grease, and other discussions which are to follow.

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study of these reactions by Wood, Lowy and Faragher, the following deductions are made:

Hydrogen sulphide is converted to water and free sulphur, accompanied by evolution of sulphur dioxide from breaking down of the sulphuric acid.

Mercaptans are converted to the disulphides which are soluble in the oil and also in the sulphuric acid, and may be so removed with sufficient treatment. With a small amount of acid they first note an increase in sulphur percentage on the oil, probably due to intermediate formation of acid thiosulphates and dithiosulphates. The percentage of sulphur did not return to that of the original sample till treatment was increased to an equivalent of about 96 pounds per 50-gallon barrels for one hour. Conversion of mercaptans to the disulphides is, however, shown to be accomplished by the doctor reaction, which would of course be the logical method and the disulphide could then be removed with relatively less acid.

Sulphides and disulphides are quite soluble in sulphuric acid with little reaction of the kind which breaks down the acid to form sulphur dioxide.

Thiophene is converted to thiophene-sulphonic acid, which is then removable in solution in the acid.

Sulphones and sulphoxides dissolve readily and carbon disulphide sparingly.

Free sulphur is without reaction and not removed.

It is to be noted that in these experiments they never used less than an equivalent of 16 pounds of acid per 50-gallon barrel.

Morrell and Egloff have also shown that using sulphuric acid for sulphur reduction in gasoline is an expensive operation, and in the case of high sulphur oils is practically prohibitive if it is required to bring the percentage down to the .10 per cent specification. In a case of a gasoline with .90 per cent sulphur they show the effect of treatment of the cracked distillate from which it was produced with increasing amounts of acid on a curve from which the following points are noted:

Pounds Acid Per Bbl.	Percent in Gasoline
0	.90
10	.55
20	.32
30	.24
40	.18

It is obvious that straight run gasoline which does not contain unsaturated hydrocarbons would not take as much acid for corresponding effects upon the sulphur content.

Panhandle gasoline is successfully treated with fuming sulphuric acid which is usually added in several small dumps rather than all at once. In using fuming acid for cracked distillates it has been pointed out that the unsaturated compounds are partly oxidized to gums, and such treatment should be followed by treatment with acid of lower percentage in order to remove these substances.

TWO PARTS

From the standpoint of chemical control of acid treatment it is at once obvious that there are many things to be taken into consideration and that rough and ready tests by which the operator may check the progress of treatment are few. From the laboratory angle we may look at treatment as divided into two more or less distinct types as follows: That which has to do with reactions on hydrocarbons and is evidenced in its effect on color, and gum; and that which has to do with sulphur content. One more angle may be added which is applicable in either of the other cases, and that has to do with corrosive effect on rerunning stills. The effect of method of treatment on acid disposal and sewage problems is a story all in itself and will be so handled.

The problems of the plant operator are to a certain extent minimized by the fact that most acid treatment is applied by a continuous process, in which changes are gradual and treated products blended together, so that a general effect is all that is required. After a method is found which gives suitable results, operation may be reduced to a fairly fixed routine. Operators of experience, however, usually find a good many profitable telltales for a certain type of treatment such as odor, rate of settling, gravity of sludge, temperature of reaction, etc. But final results are what count most and the laboratory must be relied upon to interpret these in the light of treating procedure.

Decreasing the amount of acid treatment is a very decided tendency at the present time. It has been pointed out that the four variables—time, quantity, acidity and temperature—may be combined in many ways to get similar results. Recirculation of sludge, which is quite a common practice, may be looked upon as an extension of time, and changing rates of recirculation may be looked upon as affecting quantity, while both processes are accompanied by continual changes in acidity. Temperature is usually more or less fixed according to atmospheric conditions or time elapsing between distillation and treatment, except that the heat reaction, or "acid heat," may be watched as it is related to the other three variables just mentioned. Some refiners consider an acid heat of 10 degrees as the maximum allowable without danger of subsequent corrosion on rerun stills.

The chemistry of color in light distillates has been a difficult one because of the extremely small amounts of material involved. Brooks has pointed out that practically all pure hydrocarbons are colorless except the conjugated diolefines, which are yellow. More recently he has recognized a fundamental effect of acidity in the oil, and has taken a patent (U. S. No. 1,748,507) on a

(*Continued on page* 136)

Methods of Utilizing Petroleum Residuals and By-Products

Paper presented before the Second Plenary World Power Conference, Berlin, Germany, June 16-30, 1930

By DR. A. E. DUNSTAN[1]
Institute of Petroleum Technologists

IN his discussion of the utilization of various petroleum residuals and by-products for power purposes Dr. A. E. Dunstan deals with the important topics of acid sludge, petroleum coke, asphalt residues and waste gases. He reviews, in each case, various researches and experiments and results obtained in the application of these products as fuels. Part 1 of this discussion deals with acid sludge. Part 2 of the report covers the usage of petroleum coke, asphalt residues and waste gases.

THE chief refinery by-products are:
Acid sludge.
Petroleum coke.
Asphalt residues (not suitable for normal use).
Waste gases.

The problem of the utilization of refinery by and waste products has only attained real prominence in the last decade, and is due to economic factors.

Before this time the by-products which are now discussed were disposed of in the simplest possible manner.

Acid sludge produced by the sulphuric acid treatment of lubricating oils and kerosene has been a refining difficulty since the inception of the industry owing to the extreme difficulty in dealing with the large quantities produced and the highly corrosive nature of the material.

Before, economic factors made the utilization of this waste product almost a necessity in helping to reduce general refining costs the problem was simply that of disposal.

The chief methods used to dispose of it were the dumping of it in pits where it accumulated, or emptying of it into rivers, streams or the sea.

River and water pollution obviously reduces the scope for the last two methods.

Petroleum coke is produced by the destructive distillation of petroleum products and is obtained whenever these products are heated above their decomposition temperatures. The main sources of petroleum coke are coking stills and cracking units.

Asphalt residues refers to those particular residues which are not suited to the normal uses of this product, such as bituminous material for road making etc.

Waste gases, obtained in the production and refining of petroleum.

[1] Anglo-Persian Oil Company.

The petroleum industry today is continuously striving to reduce production costs, and therefore the utilization of all products from the refinery is becoming more and more important. It is this change that has caused refiners to investigate the possibilities of the use of these hitherto waste products for a variety of purposes.

This is not a subject on which one can make definite statements, as there are so many variable factors to be considered. To mention a few; the acid sludge is different in every refinery, due to the difference in the oils refined, the concentration of the acid and to the quantity of acid used. Separate groups of sludge can be differentiated which are materially different in their composition, and which are dealt with in different ways. These are:

Sludges obtained from lubricating oils and other heavy petroleum distillates.

Sludges obtained from benzines and kerosenes.

There are in addition sludges produced by other refining methods. Furthermore, there are very obviously at least two general lines to work on in attempting to utilize this product i. e.:

Recovering the acid from the sludge and reconcentration.

Finding a use for the acid sludge as produced.

Both of these basic lines of attack have received considerable attention in the past and both are in extensive and growing use today.

HISTORICAL

One has to go a long way back into the history of refining to get the first indication of the commencement of the long struggle with the product. Suffice it to say that in 1859 the subject was of sufficient importance for Henry Pemberton to take out

a patent (U. S. 24952) for the treatment of acid sludge. The process consisted of:

A preliminary heating to obtain a separation of the free sour oil.

Agitation of the acid-sludge residue with hot water and steam.

Separation of weak acid and tar.

Recovery of the weak acid by evaporation in pans.

It is of interest to note that this patent, though so old has been the basis of a very large proportion of the patents which have followed it on this subject.

Bower, in 1880, recovered sulphuric acid by washing the sludge with water in covered tanks and mechanically separating the acid solution from the carbonaceous matter and oily ingredients. Breinig, in 1884, mixed with the sludge a soap compound adapted to unite with the tar and separated the free acid from the tarry mass. J. L. Gray, in 1909, claimed the production of pitch and asphalt from petroleum sludge by digestion with water, steam, or dilute acid recovered from the sludge, until the major portion of the acid had been recovered. The tar, comparatively free from acid, was heated with a steam spray until the mass was converted into pitch. Another of Gray's patents covered a process in which the acid sludge was digested with water, air and steam, until the light constituents rose to the top. These were drawn off, and the digestion continued. A heavy residuum was drawn off from the bottom of the separator, and the weak acid finally separated.

Schildhaus and Condra, in 1910, heated acid sludge to 200 to 300° C (392 to 572° F) and at the same time introduced air into the retort at about the same temperature. The liquid hydrocarbons were distilled and condensed, and the gases, consisting largely of sulphur dioxide, were washed first with heavy hydrocarbon oil and finally with sulphuric acid.

Van Tienen, in 1911, appears to have been among the earlier inventors makig use of both heat and pressure for sludge separation. He recovered hydrocarbons and sulphuric acid from sludge by mixing sufficient water with it to dilute the acid to 52° Be. and heating the mixture to a temperature of 140 to 165° C (284 to 329° F) at a pressure of about 100 pounds per square inch. The liquid was separated into two layers one containing sulphuric acid and the other containing tar.

Early refinery practice, and the majority of the earlier patents dealt only with the acid separation from the sludge, few of them covered the reconcentration of the acid.

It is of interest to note, however, that Loftus. in 1864, and Penissant, in 1878, described methods for concentrating the separated acid.

Gronsilliers, in 1888, added sodium sulphate to the separated acid and the bisulphate was precipitated by boiling and evaporating. The precipitate was dried and the acid recovered by heating at a moderate red heat. Waring and Breckenridge mixed about four per cent sodium nitrate with sludge acid at a temperature between 60 and 180° F (15.5 to 82.2° C) to purify it and permit the recovery of the sulphuric acid. A foreign patent of interest is that of the Steaua Romana Petroleum G. m. b. H., in which the separated black acid was allowed to flow continuously into pure boiling concentrated sulphuric acid in the presence of an oxidizing current of air, the evolved acid vapors then being condensed and reconcentrated in standard apparatus.

ACID SEPARATION AND RECONCENTRATION

When it is realized that the weak separated acid can now be concentrated to 61 to 62 gravity on a commercial scale at a cost of less than $5.00 per ton it is clear that recovery of the acid from the sludge is important.

Unfortunately there are several factors which the refiner meets in attempting to use this method, the chief of which is corrosion which will be dealt with in greater detail later; further the acid sludge produced is generally viscous, causing considerable difficulty in separating the sludge and water into layers. The acid cannot in the majority of cases be removed from the sludge except by repeated boiling with water, it is then obtained in a state of dilution which makes its recovery not the simple matter that might be indicated by the above.

In the first two decades of this century the common practice in sludge acid concentration, consisted in concentrating to 60° Be in lead pans, and finishing to 66° Be in cast iron pans or glass retorts. The lead concentrating pans commonly employed varied considerably in size in the different plants. According to Day, units five feet wide by 50 feet long and 10 inches deep, as well as a series of shorter pans of the same width (15 to 20 feet long) were not uncommon. Such pans were generally constructed of 10 pounds chemical lead, and supported by perforated cast iron plates laid over the furnace flues. Heat for concentration was frequently supplied by combustion of the separated oil.

The acid left the last compartment of the pan, or the last pan of the series at about 60 to 62° Be. and passed to a series of two cast iron pans, or "stills", generally about four feet by eight feet by 10 inches deep, provided with hoods lined with acid-resisting material, leaving the end pan at a temperature of about 450° F (232.2° C) and a gravity of about 66° Be. The vapours were usually condensed in a scrubber and the weak acid returned to the system. Corrosion makes the life of these coatings very short, averaging in one western plant about six weeks, and failure of the pans frequently results in the loss of appreciable percentages of acid.

Slight improvement in this matter was obtained by passing air through the acid also by the use of

(*Continued on page* 128)

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glass and silica, and by substituting cascade systems for the pans. The last decade has seen a great decline in this method of acid sludge concentration, and though there are probably many such plants still in use, corrosion is too great a factor to encourage their more extensive use.

In the "Chemico" process: a mixture of hot air and flue gases are passed through the acid to be concentrated and a considerably lower temperature can be used than that required for the pan concentration method.

Advantages claimed are that heat transfer is better, fuel costs being correspondingly lower, operating costs including fuel, labor, general expenses and repairs, losses and royalty, is said to be fully 50 per cent less than with the pan and still system.

Another method of concentration which has come to the fore considerably in recent years in America, is the Simonson-Mantius process, which is based on vacuum distillation, with its known advantages.

A still more recent development is the Geyser system. This process resembles the Chemico process in that hot flue gases are used to supply the heat needed for evaporation of the water, but differs from it in that the evaporation is accomplished by blowing the flue gases across the surface of the liquid, which is kept in a violent state of ebullition by means of an independent stream of air.

The Chemico and Vacuum processes are two-stage systems in which the first concentration is to 60 to 62° Be, and the final concentration to 66° Be. The Geyser system is a one-stage process.

These are general methods but as has been mentioned, the variety of the sludges produced at various refineries necessitates special processes or alterations.

For example acid sludge from cylinder stock is in many cases not easily separated in the ordinary type for "cooking" kettle. The sludge being heavier than the water sinks to the bottom, and cannot be completely agitated with the water. Dependent on the nature of the acid sludge a large or small number of lumps are left, and in some cases there is unavoidable caking.

The water used in the process hydrolyzes the sulphonates and removes the acid from the surface of the lumps or cakes, thus "coking" the surface. In this manner no separation takes place in the lumps or cake.

The method of separating acid sludges under high temperatures and pressures cannot be used with most cylinder stock sludges as by this process the sludge is simply coked hard to a non-fusible mass and owing to it being heavier than the separated acid cannot be withdrawn from the separator.

To illustrate the individual methods used and necessary at different refineries with different requirements, there follows a short account of the procedure at one American refinery producing approximately 100 t of acid sludge per day.

The initial sludge is termed green sludge, owing to the fact that it contains sufficient oil to give it a green cast. The green sludge is separated in lead lined open cooking kettles. The success of the subsequent operations at this refinery depend first upon the use of light oil acid sludge with water to give a weak acid of sufficient gravity to float the green sludge at the start of the separation; and second, upon the use of sufficient acid oil from a previous treat, along with some fresh slop oil or gas oil, to extract the oil content of the sludge.

The light oil sludge is that resulting from the treating of Dubbs Pressure Distillate and is about 45° Be gravity (heavy) and contains about 58 per cent sulphuric acid. The solvent oil used may be any oil having a gravity sufficiently high to obtain separation.

The steps in the separation of the cylinder stock sludge are:

120 barrels of acid oil or "Top" oil are left in the kettle from the previous run, to act as a solvent to thin the heavy green sludge as it is drawn into the kettle.

Thirty-five barrels of light oil sludge are charged to the kettle.

About 100 barrels of hot water are added, the quantity being sufficient to separate the light oil sludge into a weak acid of 24° Be (heavy) gravity which is heavy enough to float the green sludge. This step completes the preparation of the kettle for the receipt of the green sludge. The preliminary steps require about one hour.

The green sludge is then gravitated from the agitator into the kettle. A batch uses 235 barrels of sludge. The draw takes about two hours, and during this period live steam is used in the kettle to agitate and heat the mass.

About 175 barrels of solvent oil are then pumped in, about one hour being required.

An additional 85 barrels of hot water are added over a period of one hour. During all of this time, the kettle is cooking with steam, the total cooking time being four to four and one-half hours.

After the final water is added, the steam is cut off and the contents of the kettle allowed to settle for three hours. Three layers are formed, a bottom layer of about 150 barrels of 24° Be. Acid, a middle layer of so-called "wet sludge" and a top layer of about 400 barrels of top oil. The acid layer is drawn off.

The kettle is again cooked up with live steam, the contents being thoroughly agitated for 10 minutes. The mass is allowed to settle for 1½ hours and a second acid draw is made, 70 to 90 barrels being

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obtained. If the separation is not good, several recookings may be necessary.

With all the weak acid separated and drawn, the middle "wet sludge" layer is drawn to the acid pit where the remaining weak acid can drain off.

About 285 barrels of top oil are pumped out, leaving 129 barrels in for the next run.

A typical run on a cylinder stock sludge kettle is outlined in Table 1 giving the actual acid and oil recovered.

Table 1

Charge	Kettle No. 2 Bbls.	Gravity	Batch No. 300 Acid Content Pounds
Top oil	120	21.5 A.P.I.	
Light oil sludge ...	35	50.1 Be	12,460
Green sludge	250		19,849
Solvent oil	175		
Water	185		
Total Acid in Charge.....			32,309
Recovered			
First Weak acid....	147	24.5 Be	17,520
Second Weak acid..	77	24.5 Be	9,310
Total Acid Reclaimed			26,830
Per Cent Acid Reclaimed			83
Wet sludge	111	(6.4% acid)	2,675
		Carried Fwd.	29,505
Fuel oil	285	21.7 A.P.I.	180
Top oil (left in) ...	120	21.7 gr.A.P.I.	
Total acid accounted for.....			29,685
Per cent acid accounted for.....			92

The weak acid is concentrated in a vacuum evaporator system, to 63 to 64.3° Be. This is blended with purchased fuming acid (104 per cent H_2SO_4) to make 93.5 per cent acid.

This process with its length of detail should serve to indicate the individual methods necessary and employed to meet individual refinery cases if dealing with this subject, and it should be noted that this refinery process is rather different from those that have been already referred to; it is derived from the process formulated almost simultaneously by Smitz and Seidenschur, who stated that the organic constitutents of ordinary acid sludge, which are only slightly soluble in benzine and similar solvents, are easily absorbed by solvents such as the middle and heavy oils obtained from the distillation of crudes and tars. The addition of these oils as solvents enables them to unite with the organic bodies present and separates out the acid in a very much greater strength than would be obtained by water separation.

ACID SLUDGE OBTAINED FROM THE REFINING OF KEROSENES AND SIMILAR LIGHT DISTILLATES WITH SULPHURIC ACID

This sludge is visibly different from the sludge obtained from refining lubricating oils insomuch as it is a much lighter, more fluid liquid, usually black in appearance, of a "tarish" nature and with a pungent acid smell. On dilution with water it separates fairly easily into several layers. The lower being composed of acid of dark color, this latter characteristic being caused by the organic substances held in it. The upper layer consists of a liquid resinous substance which is the polymerised and sulphonated product of the mixture of the original spirit and sulphuric acid. There is also a definite middle layer of sulphuric acid esters, and sulphonic acids which can be removed by water washing. Further, there are in many cases intermediate layers between these definite layers.

It will be seen that the sulphuric acid can be reasonably easily removed by the addition of water, and on separation can then of course be reconcentrated by evaporation.

The word "reasonably" is used because the acid separated by water contains in solution, besides sulphonic acids and salts of nitrogenous base, a considerable amount of tarry bases, which on the evaporation of the acid separate out and must be continually removed.

This separation is never complete, a quantity of tarry substances are at the conclusion of the separation left in the solution, they usually serve to give the acid a dark color. Oxidation of these compounds naturally occurs in the concentration of the acid accompanied by the liberation of sulphur dioxide.

Actually the acid on initial separation has to be further diluted with water a number of times and after each dilution a further deposition of tarry substances will occur.

The resultant dilute acid is always dark, usually black in fact, and in this form finds but little use in the hands of the refiner.

It can, however, be made pure if the black acid is concentrated to a fairly high strength and then mixed with pure sulphuric acid, allowed to flow into heating vessels in the presence of a flow of air and subjected to a temperature of around 300°.

Little use has so far been found for the organic part of the acid sludge. One use and least of interest is that of using this tarry substance after treatment for the production of artificial asphalt, and when this operation is made without the use of air an elastic substance is formed.

The sulphonic acids which have been referred to are in some cases themselves extracted and used in a variety of industrial purposes.

UTILIZATION OF THE ACID SLUDGE AS IT IS PRODUCED

The production of acid sludge is increasing, and will probably further increase. The methods of utilization that have been mentioned do not absorb in the majority of cases anything like the amount produced. For example, one well known American

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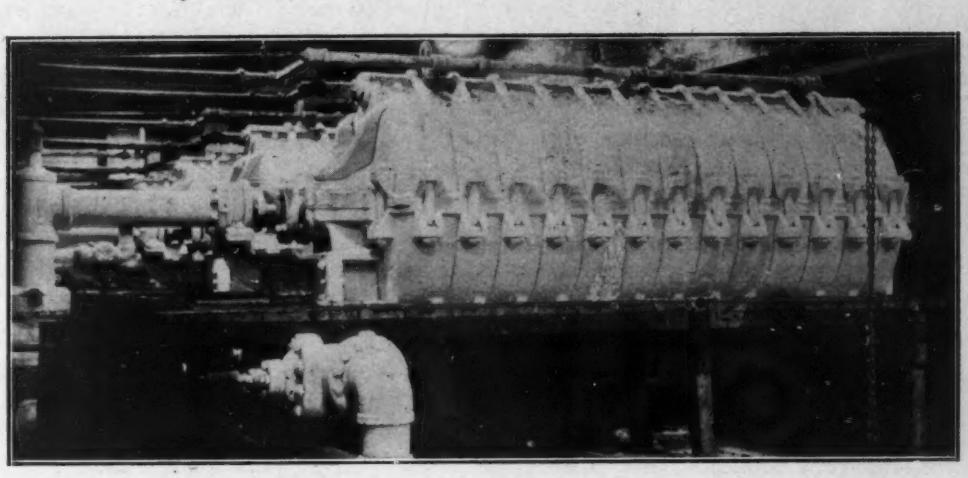

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refiner asked how much sludge he had on stock gave his answer in acres.

Most of the known methods of utilization necessitate movement of the sludge, here, as has been previously remarked, corrosion is a very big and often limiting factor. Against the value of the final by-product obtained must be offset the prime cost and cost of repairs to conveying machinery and labor involved.

There has only been one efficient form of utilization found under these circumstances, and that is use as fuel.

The acid sludge as produced cannot naturally be used as direct fuel owing to its high acid content. It can however be mixed in varying proportion with fuel oil and then in this fluxed state is a reasonably satisfactory burning fuel though it suffers from many disadvantages which will be dealt with at greater length later.

Here again there is a wide variance in method used in different refineries, though basically they are the same.

As every refinery utilizes heat in varying amount, the ability to use this hitherto waste product as a fuel is an economic factor of considerable importance. The disadvantages that offset at first sight the apparent economic advantages are firstly corrorosion, secondly unless the sludge can be used with the minimum of movement it is necessary to neutralize it to cut down corrosion losses. If. however, neutralization is necessary it naturally increases the cost as agitators or mixers are necessary and furthermore the resultant fuel product has a considerably higher ash content and is therefore not so satisfactory. When the acid sludge is fluxed direct with fuel oil or other distillate it is a reasonably good fuel particularly so owing to its low ash content.

One or two refinery processes in brief should be of interest.

At one American refinery the Bright Stock acid tar is drawn off, strained and then pumped to the top of the mixing tanks. Here it is mixed with fuel oil and heated by coils to about 100°F is afterwards agitated in a specially designed plant, made to cover the variance in the nature of the sludge received i. e. from a mobile liquid in summer to that of a very viscous product in winter. The mixture is then withdrawn from the rank and pumped to a sloping supply tank. heated underneath by steam coils. This last tank delivers it at a temperature of 100° F to the air-oil burning system used, the flow being regulated by a control valve.

Another refinery process is as follows: Two kettles which were formerly used as Acid Separators in an acid recovery system, were rehabilitated for use in the sludge fluxing process. They have a capacity of 250 barrels, are 26 feet 6 inches in diameter at the top and taper to 22 feet six inches at a distance nine feet six inches below the top. From this point a 30° cone serves as the bottom of the kettle. The kettles are equipped with coils through which steam or air can be admitted for purposes of agitation. Steam and air may also be admitted through a suction line. The sludge acid from the cylinder stock is divided into two equal dumps and two batches of sludge are fluxed in separate kettles. To start the process a quantity of 13 to 15 gravity fuel oil equal to the amount of sludge, is pumped into the kettle and agitation started by admitting air through the suction line entering the bottom of the kettle.

Practice has shown that the temperature of the fuel oil should not exceed 120° F (49° C) to obtain best results. The cylinder stock is treated at a temperature of 160° F (71° C) and the sludge formed from the first dump of acid is pumped into the kettle through strainers at the top of the kettle. These strainers consist of short 12-inch pipe with welded bottom plates which are perforated with ¼-inch holes. They are equipped with steam connections so that they may be steamed in case they become plugged up. The strainers aid in breaking up and disintegrate the sludge mass. While the sludge is being pumped into the kettle the contents are kept well agitated by means of air introduced at the bottom of the kettle. This eliminates the possibility of the sludge falling to the bottom of the kettle and forming a hard mass which would be difficult to work off. When all the sludge, about 125 barrels, has been transferred to the kettle, air is introduced through a line extending over the top and into coils which are installed on the inside walls of the kettle. Introduction of air through these coils gives the contents of the kettle the necessary agitation and during this agitation the air is cut off at the bottom inlet.

This air agitation is kept up for a period of five to ten minutes at which time a pump takes suction from the bottom of the kettle and discharges into it again through the strainers. During this circulation operation the temperature of the oil is raised to 180 to 200° F (82 to 93° C) by means of closed steam coils. This circulation and agitation is continued until the batch is completed or when all the sludge has dissolved into the Fuel Oil giving a smooth homogenous product.

If the sludge should begin settling on the bottom of the kettle it was found that it could be worked back into the oil by the introduction of steam through the suction line at the bottom of the kettle.

There are several factors which determine the ease and success with which a batch of sludge is fluxed off. If a higher tempertaure than 160° F (71° C) is used for acid treating the sludge will be hard and gritty and will form a harder coke. Difficulties are also encountered when trying to disintegrate such a hard sludge in the fuel oil. If the correct temperature is used for acid treating and the

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temperature of the Fuel Oil is too high at the beginning of the fluxing operation, the sludge will coke and harden when it comes in contact with the hot oil and will cause difficulty in handling.

Sludge from the second acid dump is handled differently in that a greater percentage of fuel oil is used to work it off. One hundred twenty-five barrels of fuel oil are used to about 40 barrels of sludge. This is necessary because of the hardness of the second sludge as compared to the first and the greater difficulty in disintegrating and dissolving it in the fuel oil.

The time required for completing a batch of sludge varies from one to four hours depending upon the nature of the sludge.

BURNING OF THE SLUDGE FUEL

When the sludge fuel is judged to be of satisfactory quality it is pumped into a fuel storage tank at the still battery. The oil is kept agitated with a small quantity of live steam and the tank is equipped with a pump which takes suction on the bottom and discharges back through the top, thus keeping the fuel oil in constant agitation and preventing the formation of any solids which would tend to settle out. The fuel oil is fed by gravity to injector type oil burners which have been installed under all stills.

QUALITY OF FUEL

Average tests on a completed batch of sludge fuel are

Gravity	10.3° Be
Ash	0.15%
Acidity	1.0%
B. Th. U. per lb.	16800

Sludge fuel as manufactured in the above manner is found to be a satisfactory fuel for heating the shell and pipe stills at the refinery. Although it would appear that there would be some disadvantage in the use of such a fuel, no difficulty has been encountered. The small amount of ash in the fuel is carried out with the waste gases and none of it has accumulated on the still bottoms or tubes. This eliminates any objection that a deposit would build up on the exposed surfaces and eventually cause local overheating.

These examples of different refinery practice should serve to indicate that there is a definite economical use for acid sludge as a cheap yet under carefully devised conditions, efficient fuel.

BURNING PROCESSES FOR THE SLUDGE

There are in general two main types of burners.

The rotary type of burner, is little more than a fuel incinerator. In many refinery cases where the production of acid sludge is greater than the amount of sludge that can be utilized by other methods, this type of burner is used to dispose of the surplus.

In size they vary greatly being built to suit individual refinery requirements, 4000 pounds per hour is the largest size the author is aware of but this figure is probably exceeded in many cases.

The other types of burners are varieties of air oil injection burners for heating stills and other plant.

A little greater detail on these methods of combustion should be of value.

The rotary type of burner as has been stated is little more than an incinerator, it will handle with ease any waste fuel from refineries such as the acid sludge as produced, the wet sludge from the cooking kettles, dried sludge from sludge dumps, asphaltic residues and if necessary acid sludge fuel mixture. The burner is usually a form of rotary kiln generally in a horizontal position.

An American rotary burner which will serve to illustrate the type admirably is the Duncan. This is a horizontal rotary retort of varying capacity rotated at roughly 20 revolutions per hour. The rear end is equipped with a fuel hopped and a variable speed screw conveyor which feeds the fuel in the burner at the desired speed. The forward end of the burner is restricted in size to enable it to hold the solid fuel in the kiln until entirely consumed. The metallic portions of the burner are made of a special cast iron to reduce corrosion losses.

The sludge is fed through the screw conveyor and falls on to the incandescent fuel bed or burner lining where it almost instantly ignites. The volatile portions are vaporized and burned as gases and vapors in the early part of the cycle, and the residue is coked. The rotation of the burner keeps the fuel agitated, continually bringing fresh fuel against the heated lining where it is cracked to gas and coke.

When burning plastic or semi-fluid material, the fuel softens and tends to remain in mass on the bottom of the burner. High pressure jets of air or steam are directed against the plastic mass to agitate it until such time as the fuel is cracked to gas and coke by the heat of the kiln walls. Experience has shown that steam functions equally as well as compressed air for this purpose. Air from a forced draft is admitted around the screw conveyor, and passes through a series of vanes which give it a rotary motion. This causes the air to hug the inside of the burner in such a way as to be brought in close contact with the fuel bed and any liquid fuel which may be carried up on the sides of the burner. The air admitted to the upper part of the burner supports the combustion of the gases. Tuyeres located below the fuel line furnish air for the combustion of the solids.

The rotation of the burner rolls the fuel mass over and over, advances it towards the front of the burner and breaks up the coke. The forced draft picks up the small coke particles and ash and carries them into the boiler combustion space. Sufficient primary air may be used to practically complete the combustion, or if preferred, the burner can be operated as a gas producer and secondary air used in the furnace

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proper to complete the combustion. The wet sludge is picked up from the storage pit by means of a monorail crane and clam-shell bucket, and is charged into a storage hopper located directly behind the burner. A variable speed, cast iron drag chain conveyor breaks the sludge into small lumps and conveys it from the storage hopper to the small feed hopper on the burner proper. The conveyor is controlled by a variable speed motor at such a rate as to keep the feed hopper about half full of fuel. The sludge is charged from the feed hopper into the burner by means of the screw conveyor at whatever rate that is desired. Sufficient gas is burned at all times to insure ignition of the heavy fuel. This usually requires about 6000 cubic feet per hour.

BIBLIOGRAPHY

The air oil injection burners are of varying nature. In general however they are used when the fuel is used for heating purposes, pipe stills, etc. These burners operate on closed furnaces either injecting the fuel under high pressure in the form of a mist from which it is suitably ignited to the fire space under the still tubes or along tubes in parallel to the still tubes, these tubes being perforated with small holes, the fuel flowing out in thin streams from which it is suitably ignited. There is one great difficulty in burning the fuel and that is once again corrosion.

In heating stills with air oil burners using acid sludge fuel mixtures corrosion is a serious trouble.

The operating temperatures are very obviously too high to allow any moisture deposition and the corrosion must take place during the periods the still is not in use when they would have condensed moisture on them. When boilers are shut down periodically and the tubes flushed with water heavy condensation on the outside very naturally takes place.

On heating up again the SO_2 and SO_3 fumes from fuel form with moisture sulphurous and sulphuric acid, which readily attacks the iron.

Corrosion is heaviest on the lowest tubes as the moisture drips on to these from those above.

The remedy lies in the abolition of moisture.

In some cases refiners use caustic soda, or other equally strong alkaline material in admixture with the sludge, in order to partially neutralize the acidity, but as a very large quantity would be required, and considering the cost of the neutralizing agent, this is hardly worth while when the raw acid sludge can be satisfactorily burnt, if necessary precautions are taken.

At a large English refinery, however, using the calcium hypochlorite process of refining a portion and the residue of the lime sludge is used to neutralize the light acid sludge produced in the treatment of light distillates, kerosenes, etc.

The heavier sludge from lubricating oil and bright stock treatment is water washed to separate a quantity of the oil which is then used as a refinery fuel.

The residue is disposed of in the most convenient way in sludge ponds.

(To be concluded next month)

Chemical Treatment of Petroleum Distillates
(Continued from page 120)

oil, and has taken a patent (U. S. No. 1,748,507) on a process for stabilizing gasoline for color by the addition of a small amount of ammonia to prevent acid formation in the stored products.

The many attempts to replace sulphuric acid treatment with other methods have often failed in only one or two respects, but have contributed to specific knowledge valuable in chemical control of treating processes.

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Gasoline Specifications

Paper read before the Petroleum Technologists of the National Petroleum Association on June 6, 1930, at the Bureau of Standards, Washington.

By OSCAR C. BRIDGEMAN

FEDERAL specifications for gasolines are based on the research work of the petroleum and automotive industries, and of various government departments including the Bureau of Standards. Their aim is to ensure the purchase of good gasolines by the government, at a reasonable cost, on the basis of tests which are significant from the standpoint of engine performance. While all of the tests employed at present may not be as significant as is desirable, research work along these lines is continually being conducted at the bureau and elsewhere, the results forming a basis for changes in the tests and modifications in the specifications leading toward the desired end.

The present discussion is limited to those tests and specifications which are now in effect or the modification of which is under contemplation. These include volatility, vapor pressure, gum content and sulfur content, which will be considered briefly in the order named.

One of the most important characteristics of a fuel from the standpoint of engine performance is the volatility, or the ease with which the gasoline will evaporate under the given conditions. The test for volatility consists in distilling the gasoline under specified conditions which have been standardized by the American Society for Testing Materials. The significance of this test has been amply demonstrated by the research work of the bureau during the past few years, which is summarized in a recent paper.[1] The interpretation of the volatility test in terms of engine performance has been so successful that, given the requirements of the engine, it is now possible to specify the desired volatility characteristics with reasonable assurance. This interpretation is only significant when the distillation points are expressed in terms of percentage evaporated, which is the percentage distilled plus the distillation loss. Some of the more important phases of engine performance related to volatility are briefly discussed in the following sections.

Engine Starting — In order that an engine may start, an explosive mixture must be formed in the cylinders, and the ease with which this occurs is determined by the temperature at which 10 per cent of the gasoline is evaporated in the A. S. T. M. distillation test.[2] A lower 10 per cent point indicates easier starting under comparable conditions. For the average car on the road and an average gasoline, the temperature below which starting will not be easy is approximately 140°F. below the A. S. T. M. temperature at 10 per cent evaporated.

Vapor Lock — Vapor lock is the partial or complete interruption of gasoline flow in the fuel feed lines due to the formation of bubbles of gas or vapor. It is ordinarily not serious until the gasoline commences to boil and this temperature for properly stabilized gasolines is the A. S. T. M. 10 per cent point.[3]

Acceleration — In a given engine, the effectiveness of the fuel for producing acceleration appears to be dependent upon the A. S. T. M. distillation curve, better acceleration being obtained with a fuel which is more volatile between the 10 per cent and 70 per cent temperatures when a constant carburetor setting is employed and too rich a mixture is not used. On the other hand, manifold temperature and carburetor setting could probably be chosen in each case so as to give the same acceleration with each fuel.

Distribution—The ease of mixture distribution, when the engine is warmed up, depends upon the A. S. T. M. distillation temperatures between 50 per cent and 90 per cent evaporated. A more volatile fuel in this range should give better distribution.

Crankcase Oil Dilution — The extent of oil dilution depends upon the dew point of the gasoline, which is the temperature of complete evaporation of the air-fuel mixture. The dew point is related to the 90 per cent A. S. T. M. point,[4] so that under comparable conditions, dilution is less with fuels having lower 90 per cent point temperatures.

Fuel Consumption — Fuel consumption is essentially independent of volatility for all fuels give the same mileage, with very minor variations, when the carburetor is adjusted properly for each fuel. With a fixed carburetor setting, different fuels may give different mileages depending upon the carburetor setting and the operating conditions.

Power — Power is likewise independent of volatility, for all fuels give essentially the same power if the carburetor is properly adjusted for each fuel. With a

[1] S. A. E. Journal, October 1929, p. 345.
[2] S. A. E. Journal, March 1927, p. 353.
[3] A. P. I. Bulletin, January 3, 1930, Sec. III, p. 4.
[4] S. A. E. Journal, 23, 478 (1928).

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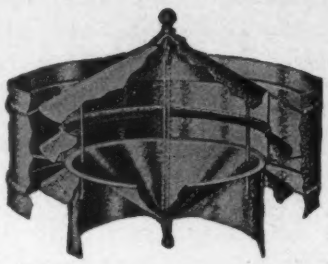

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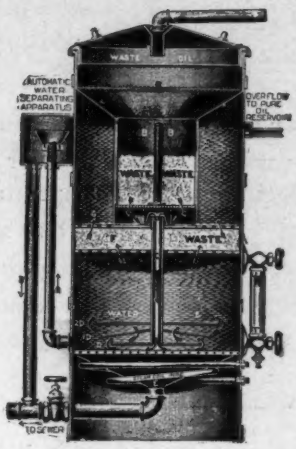

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fixed carburetor setting, power may vary slightly depending upon various factors.

VOLATILITY REQUIREMENTS

In embodying the results of the above researches into gasoline specifications, the following volatility requirements are specified:

Maximum 10 per cent point to ensure easy starting.

Minimum 10 per cent point to minimize vapor lock.

Maximum 50 per cent point to tie down the distillation curve between the 10 per cent and 90 per cent points to secure good acceleration on the one hand and good distribution on the other hand.

Maximum 90 per cent point to reduce crankcase oil dilution.

The initial point, the end point and the gravity may be significant in connection with a specific refinery output, but in general they are not significant as regards volatility and engine performance. The aviation gasoline specifications will probably be brought in line with the above specification points.

The vapor pressure test is important from the standpoint of vapor lock. While the 10 per cent point is indicative of vapor lock with properly stabilized gasolines, it is not so satisfactory in the case of fuels containing more than traces of propane. The vapor pressure test is satisfactory for all gasolines, and its introduction into specifications is under consideration to replace the minimum 10 per cent point requirement. After extensive work with a complicated laboratory vapor pressure method, it was concluded that the simple Reid method was satisfactory for practical purposes. A high vapor pressure indicates greater danger from vapor lock.

Gum present in gasolines at the time of use may cause objectionable deposits in the intake manifold and on the intake valves. Two problems are involved, the gum content at the time of test, and the gum which forms during storage. The bureau and a number of industrial laboratories are working intensively on both problems, but no tests have been conclusively proven as satisfactory to date. The present copper dish method is not satisfactory, and when suitable test methods have been developed and the permissible gum content has been determined, these will doubtless be incorporated into all gasoline specifications for the government.

TEST FOR SULFUR

The test for sulfur is reasonably satisfactory, but further work should be done to establish the permissible sulfur content. The bureau is not engaged in any sulfur research at present, but a program of work along these lines is contemplated.

Gasolines which the government can purchase on specifications are listed below.

U. S. Motor gasoline for general use.

*Motor Fuel F for freezing temperatures.

*Motor Fuel T for tropical storage.

Motor Fuel V for special purposes and for 0°F. temperatures.

Domestic Aviation gasoline.

Fighting Aviation gasoline.

The naming of the fuels marked * has not been finally adopted as yet.

TABLE 1
PRESENT SPECIFICATIONS

A. Motor Gasolines

	U. S. Motor	Motor Fuel F	Motor Fuel T	Motor Fuel V
10% Point, max.	80°C(176°F)	70°C(158°F)	80°C(176°F)	65°C(149°F)
min.	50°C(122°F)	50°C(122°F)	60°C(140°F)	50°C(122°F)
50% Point, max.	140°C(284°F)	140°C(284°F)	140°C(284°F)	125°C(257°F)
90% Point, max.	200°C(392°F)	200°C(392°F)	200°C(392°F)	180°C(356°F)
End Point, max.	225°C(437°F)	225°C(437°F)	225°C(437°F)	200°C(392°F)
Recovery, min.	96%	96%	96%	96%
Gum, max.	....	....	....	....
Sulfur, max.	0.10%	0.10%	0.10%	0.10%

B. Aviation Gasolines

	D. A. G.	F. A. G.
5% Point, max.	75°C(167°F)	65°C(149°F)
min.	50°C(122°F)	50°C(122°F)
50% Point, max.	105°C(221°F)	95°C(203°F)
90% Point, max.	155°C(311°F)	125°C(257°F)
96% Point, max.	175°C(347°F)	150°C(302°F)
End Point, max.	190°C(374°F)	165°C(329°F)
Recovery, min.	96%	96%
Distillation loss, max.	2%	2%
Gum, max.	3 mg	3 mg
Sulfur, max.	0.10%	0.10%

NOTE I — All temperatures refer to percentages distilled and not percentages evaporated.

NOTE II — For the motor gasolines, the minimum 10% point shall be lower 3°C(5.4°F) for every per cent distillation loss less than 4 per cent.

NOTE III — The nomenclature for Motor Fuels F and T have not been officially adopted as yet.

Propose Revision of Federal Specifications Covering Motor Gasoline

PROPOSALS of the Technical Committee on Lubricants and Liquid Fuels of the Federal Specifications Board for revision of federal specifications for gasoline were discussed at a joint meeting of Committee D-2 on Petroleum Products and Lubricants, American Society for Testing Materials, and the Committee on Testing Methods and Specifications, Division of Refining, American Petroleum Institute, at an Atlantic City meeting June 24. Recommendations were made at a subsequent session to the Advisory Board to the government technical committee and are to be transmitted to that group in the near future.

The contemplated revision calls for replacing the specifications for U. S. Motor Gasoline and Motor Fuel V, which became effective September 11, 1929, by four complete specifications. These will cover U. S. Motor Gasoline, Motor Fuel F, Motor Fuel T and Motor Fuel V, specifications for Motor Fuels F and T replacing the alternative provisions of the present U. S. Gov-

ernment Motor Gasoline for a lower maximum 10 per cent point and a higher minimum 10 per cent point respectively.

It is proposed to write the specifications in terms of per cent evaporated rather than per cent recovered, and to substitute vapor pressure limits for minimum 10 per cent points. The nature of the product covered also has been modified.

F. A. Hull, General Electric Company, Schenectady, New York, is chairman of Committee D-2 and K. G. Mackenzie, The Texas Company, New York, is chairman of the Institute's Committee on Testing Methods and Specifications. Members of the Advisory Board, in addition to Chairman Delbridge, who represents the American Society for Testing Materials, are:

R. P. Anderson, American Petroleum Institute; H. W. Camp, Western Petroleum Refiners Association; O. P. Keeney, National Petroleum Association; C. F. Kettering, Society of Automotive Engineers; and G. G. Oberfell, Natural Gasoline Association of America.

Proposed Revision F. S. 622 A, Federal Specification for United States Government Motor Gasoline.

Distillation Range—When the thermometer reads 75° C. (167° F.) not less than 10 per cent shall be evaporated.

When the thermometer reads 140° C. (284° F.) not less than 50 per cent shall be evaporated.

When the thermometer reads 200° C. (392° F.) not less than 90 per cent shall be evaporated.

The end point shall not be higher than 225° C. (437° F.).

The residue shall not exceed two per cent.

Per cent evaporated shall be found by adding the distillation loss to the amount collected in the receiver at each specification temperature.

5*f*. *Sulphur*—Method 520.11. Sulphur shall not exceed 0.10 per cent.

5*g*. *Vapor Pressure Method*—The vapor pressure at 37.8° C. (100° F.) shall not exceed 10 pounds per square inch.

Proposed Revision F. S. 622 A, Federal Specification for Motor Fuel F.

Distillation Range—When the thermometer reads 65° C. (149° F.) not less than 10 per cent shall be evaporated.

When the thermometer reads 140° C. (284° F.) not less than 50 per cent shall be evaporated.

When the thermometer reads 200° C. (392° F.) not less than 90 per cent shall be evaporated.

The end point shall not be higher than 225° C. (437° F.).

The residue shall not exceed two per cent.

Per cent evaporated shall be found by adding the distillation loss to the amount collected in the receiver at each specification temperature.

5*f*. *Sulphur*—Method 520.11. Sulphur shall not exceed 0.10 per cent.

5*g*. *Vapor Pressure Method*—The vapor pressure at 37.8° C. (100° F.) shall not exceed 12 pounds per square inch.

Proposed Revision F. S. 622 A, Federal Specification for Motor Fuel T.

Distillation Range—When the thermometer reads 75° C. (167° F.) not less than 10 per cent shall be evaporated.

When the thermometer reads 140° C. (284° F.) not less than 50 per cent shall be evaporated.

When the thermometer reads 200° C. (392° F.) not less than 90 per cent shall be evaporated.

The end point shall not be higher than 225° C. (437° F.).

The residue shall not exceed two per cent.

Per cent evaporated shall be found by adding the distillation

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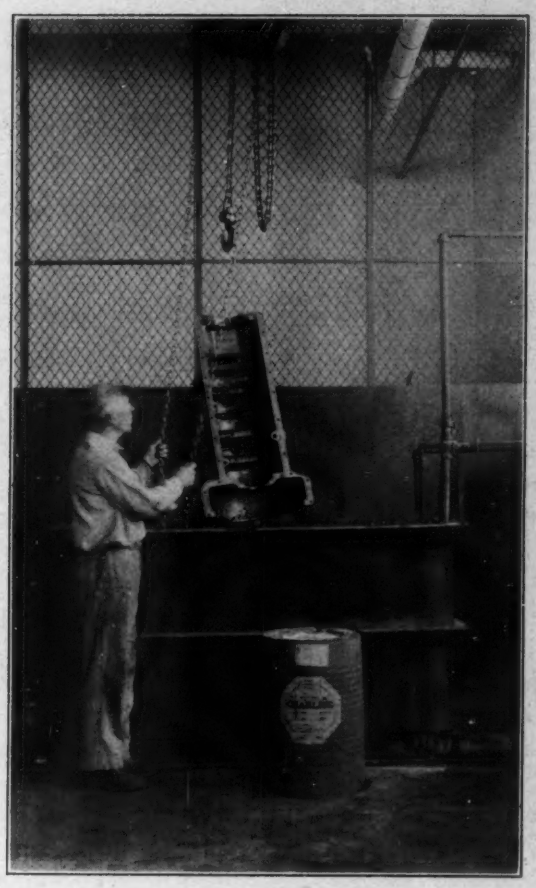

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loss to the amount collected in the receiver at each specification temperature.

Sulphur—Method—520.11. Sulphur shall not exceed 0.10 per cent.

Vapor Pressure—The vapor pressure at 37.8° C. (100° F.) shall not exceed eight pounds per square inch.

Proposed Revision of USGMS 623, Federal Specification for Motor Fuel V.

Distillation Range—When the thermometer reads 70° C. (158° F.) not less than 10 per cent shall be evaporated.

When the thermometer reads 125° C. (257° F.) not less than 50 per cent shall be evaporated.

When the thermometer reads 175° C. (347° F.) not less than 90 per cent shall be evaporated.

The end point shall not be higher than 205° C. (401° F.).

The residue shall not exceed two per cent.

Per cent evaporated shall be found by adding the distillation loss to the amount collected in the receiver at each specification temperature.

Sulphur—Method 520.11. Sulphur shall not exceed 0.10 per cent.

Vapor Pressure—The vapor pressure at 37.8° C. (100° F.) shall not exceed 10 pounds per square inch.

More Manufacturing Expansion Indicated

THROUGH the addition of new refineries, expansion of older plants, enlargement of cracking departments and the erection of new natural gasoline extraction plants, the manufacturing branch of the petroleum industry continued to expand during the past month. Nine new refineries were announced or proposed, three of which had no definite date of construction; the remaining six being assured of erection. Six new natural gasoline plants were reported under construction in various fields.

The important project of the month was the announcement by Union Gulf Corporation, a subsidiary of Gulf Oil Corporation, that it would build a refinery at Pittsburgh, Pennsylvania, probably one at Cincinnati and would enlarge the Paragon Refining Company plant recently purchased at Toledo, Ohio. Skelly Oil Company proposes a new refinery at Pampa, Texas.

McMillan Petroleum Corporation is erecting a new 2500-barrel refinery at Norphlet, Arkansas, and will ultimately dismantle its original installation at El Dorado. Another plant for Oklahoma City is indicated by the construction work started by Black Gold Refining Company, with still another plant proposed by Altitude Petroleum Company and Peveto & Peacock, who have purchased the West Kansas Refining Company plant at Russell, Kansas, with intentions of moving it to Oklahoma City.

Eastern Oil & Refining Company has been formed in California to erect a small refinery in the industrial district of Los Angeles. Houston Oil Company is reported contemplating a refinery at Corpus Christi, Texas, in connection with its other activities in that territory. Big Horn Oil & Gas Company, Billings, Montana, is reported erecting a small plant there. Wolverton Refining Company has begun construction work on a skimming plant east of Olney, Texas.

The old refinery of Sullivan Refineries, Inc., at Dayton, New Mexico, has been purchased by California interests who plan rebuilding and resumption of operation. In Michigan, Roosevelt Oil Company has started operating its plant at Mount Pleasant which it moved from Muskegon where it was formerly operated as the Michigan Central Refining Company unit. Cosden Oil Company at Big Spring, Texas, is enlarging to 16,500 barrels through installation of a new unit.

Globe Oil & Refining Company has completed erection of its 6000-barrel combination skimming and cracking unit. Pure Oil Company is adding two Gyro vapor phase units at its Heath, Ohio, plant and one unit at Muskogee, Oklahoma. A Gyro vapor phase unit is operating for Petroleum Refineries, Inc. at Killingholme near Hull, Yorkshire, England. Raffinerie Nationale de Petroles, S. A. at Terdonck, near Ghent, Belgium, has completed construction of its Jenkins cracking unit. The Royal Dutch-Shell group is reported in agreement for foreign rights of the True Vapor Phase process having formed a subsidiary company owned partly by Petroleum Conversion Corporation and partly by a subsidiary company, Bataafsche Petroleum Maatschappij. Royal Dutch has also entered into contract with Standard Oil Company of New Jersey and I. G. Farbeindustrei to participate in non-American rights, patents, and the like, in the utilization of hydrogenation.

Del Rey Oil & Refining Company plans the immediate construction of a natural gasoline plant in the new field near Venice, California. In the same field the Ohio Oil Company is completing a natural gasoline plant located on the Recreation Gun Club lease.

In the Big Lake field, Reagan County, Texas, Signal Gasoline Company is erecting its second gasoline plant in this field.

Pratt, Knox, Inc. is constructing a new gasoline extraction plant in the Earlsboro pool of the Greater Seminole area, Oklahoma, and south of this Empire Oil & Refining Company is building a new plant in the Asher-Wanette field.

Phillips Petroleum Company has announced plans for the construction of a new plant in the Hobbs area, Lea County, Southeastern New Mexico. Capacity is reported at 50,000,000 cubic feet per day.

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The Fractionation of Absorption Oil

(*Continued from page 91*)

ture can be fairly closely approximated by the Clausius-Clapeyron equation

$$\log_{10} P_2 - \log_{10} P_1 = \frac{}{4.606} L \left(\frac{T_2 - T_1}{T_2 \times T_1} \right)$$

where P_2 is the fractionator pressure or oil pressure, P_1 is the pressure to be determined for the oil at absorption temperature L = the molal heat of evaporation which can be determined or taken approximately as 10,700, T_2 and T_1 are the absolute temperatures at feed plate and absorber respectively. An inspection of the equation is enough to show that higher fractionator temperatures or lower fractionator pressures, other conditions remaining the same, will give a lower absorption oil pressure at absorption temperatures. Where the oil vapor pressures and temperatures are known at feed plates and absorber the correct value of L to use in the equation can be computed and a set of curves drawn.

Returning again to the problem under consideration, the mol per cent or mol fraction of vapors left in the oil has been approximated. It is obviously of some importance to have an idea as to what constituents remain in the oil and their relative proportions. Here again it is necessary to resort to the ultimate gas analysis of inlet and exit gases from absorption and to the temperature-pressure curves for the pure hydrocarbons. The chart prepared by Coates and Brown is very convenient for this purpose. (University of Michigan circular series No. 2. Price $1.00.) The existing equilibrum is determined by the partial pressure or volumes of the vapors existing above the oil on the feed plates, so when the vapor pressure of a hydrocarbon in solution in the oil on the feed plate attains a vapor pressure equal to the per cent volume or partial pressure of its vapor, equilibrium is attained. As an arbitrary example say the constituent is butane which exists to the extent of 40 per cent by gas volume of the total vapors of saturation. The vapor pressure of pure butane is 600 pounds at 320°F or feed plate temperature and its mol ratio to the mol unit of absorption oil is $20 \times .4 = 8\%$. The partial pressure of butane is $.40 \times 27 = 10.8$ pounds at fractionator pressure corrected for oil pressure or at least would be that if all absorbed materials were vaporized. What mol per cent of butane will give a vapor pressure equal to 10.8 pounds? This is approximated by using the vapor pressure of the pure butane at 320°F $= P_b$ then $(10.8 \times 100) \div P_b =$ mol per cent in solution necessary to produce this pressure. If vapor pressure of pure butane equals 600 pounds at 320°F $= P_b$ there is 1.8 mol per cent of butane to oil. The other hydrocarbons are calculated in the same way and give values the sum of which equal to the total mol per cent saturation of the oil and the sum of their vapor pressures in the oil $\Sigma P = 27$ pounds.

TOTAL SEPARATION

In order to effect total separation of absorbed material from the absorption oil on the feed plates, the vapor pressure of the oil must equal or exceed the operating pressure. This point can be determined from the temperature vapor pressure curve for the stripped oil. The amount of oil that will be vaporized is approximated by the use of the Clausius-Clapeyron equation and the equilibrium boiling point curve. The procedure is as follows: P_2 = fractionator pressure P_1 = atmospheric pressure, L = latent heat of evaporation per mol as actually determined for two temperatures, T_2 = feed plate temperature in degrees absolute and T_1 = the temperature to be found from the equation. The per cent fraction of distillate over on the equilibrium boiling point curve corresponding to this temperature T_1, will be sufficiently accurate for most purposes of design and operation. For a description of an equilibrium boiling point still refer to Brown (Transactions A.I.C.E. 1928, page 88). The vapor volume due to the oil is computed by using the mol per cent vaporized at equilibrium, from which the total heat required for vaporization at the feed plate of the fractionator can be estimated, using for this purpose the molar value for heat of evaporation. The total heat input is the sum of latent heat of evaporation and the specific heat requirements. Other heat requirements are for revaporization of tower reflux and that due to loss by radiation, also a small amount for expansion of vapors due to the pressure drop through the tower which is usually so small as to be neglected.

THE INJECTION OF STEAM

From a consideration of the effect of steam, which is to effect the equivalent of a reduction in pressure and also a means of agitation, it is readily seen that the point of injection should be beneath the oil stripping trays, which are the trays beneath the feed tray. Here the pressure reduction is relatively greater as the amount of material to be vaporized is smaller. In addition to steam the still should be

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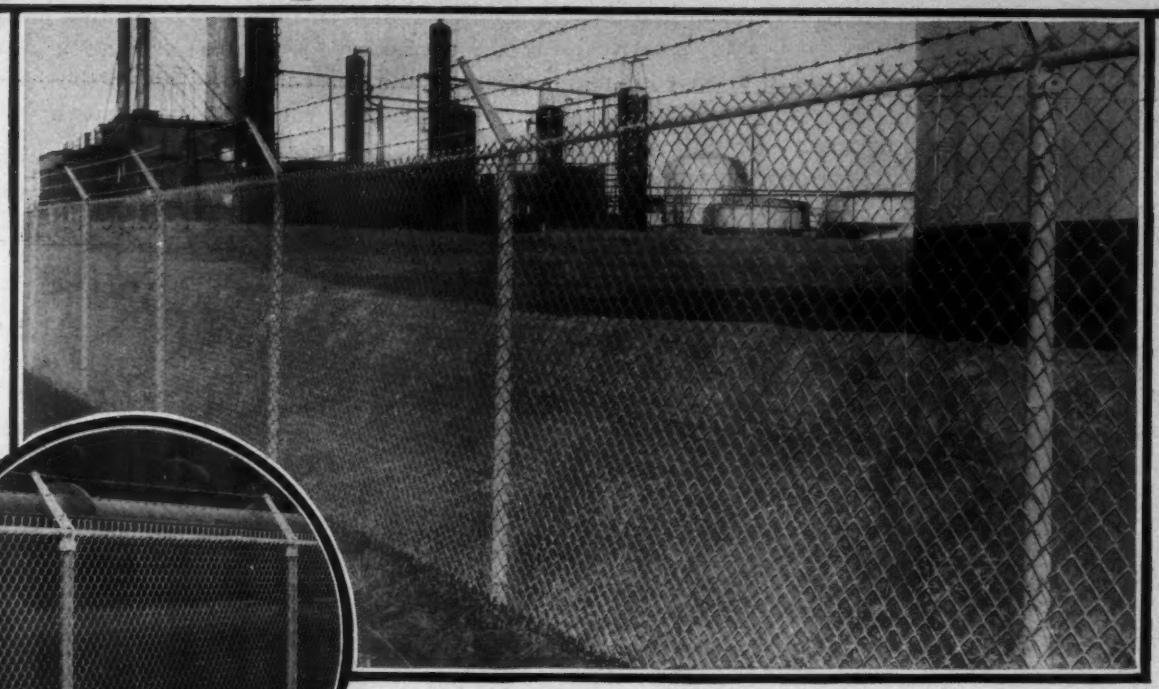

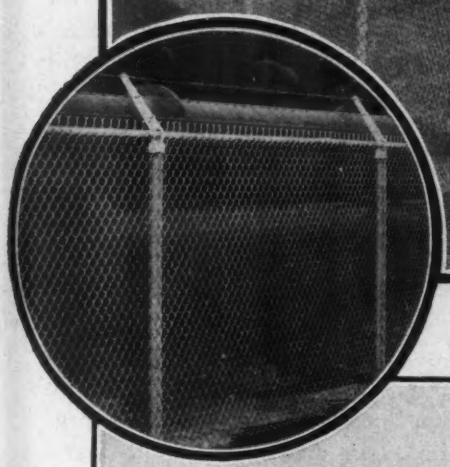

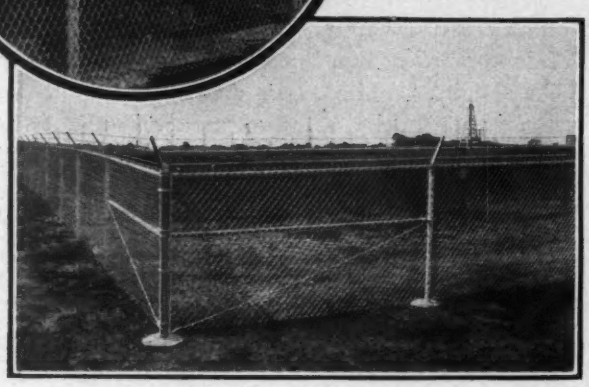

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Page Fence is made in many different styles and heights and is the only fence available of durable Armco Ingot Iron, the highest type of rust-resistant iron known. For the heavier fence constructions, where more than ordinary abuse is involved, Page H—Section Line Posts are recommended.

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equipped with a reboiler at the bottom to assure that the temperature gradient increases from the top to the bottom tray. As has already been shown, it is necessary to vaporize a portion of the oil in order to obtain complete separation on the feed plate. The greater portion of this oil is returned to feed plate in the form of reflux at a lower temperature than the incoming oil. As it drops to the feed plate, it carries with it part of the gasoline and saturation constituents, which has to be re-vaporized. The latent heat necessary for re-evaporation causes the oil temperature to fall, and unless auxilliary heat is supplied to the stripping trays, the temperature will fall from tray to tray as the oil passes down and the outlet oil will be cooler than the inlet oil to the tower. Under these conditions the outlet oil will contain a percentage saturation even though initial temperatures of the incoming oil is high enough to cause complete stripping. Where vapors are used to supplant steam this temperature drop will cause absorption effects. It is more vital under such conditions to have an efficient reboiler to assure stripped oil.

REFLUX

Where reflux is effected by cooling at the top of the column all vapors evolved on the feed plate that do not pass through the outlet are returned to the plates in the form of reflux. Where cooling and condensation takes place due to forced reflux, where the partial condensor at the top is dispensed with, as in cases where finished product is returned to the top of the column, this material adds to the total amount of reflux, and should be estimated as such in calculations of total vaporization input and output. Such columns are not as economical of heat as are the ones that use the enclosed cooling systems. Greater vapor volumes pass from the tower carrying heat. Fuel, however, is usually a minor consideration in natural gasoline plants because of its abundance and cheapness. The heating equipment however is a consideration, so from the standpoint of initial cost and cost of upkeep it is desirable to effect heat economy.

Where an enclosed coolin gsystem is used the vapors are best directed downward over the tubes by some suitable arrangement of banking and overflow between the top fractionating tray and the condensor. The heavier ends which condense out will then pass downward with the vapors and in so doing exert an absorbing effect on the ends remaining in the vapor.

OUTLET VAPORS

The percentage of oil remaining as vapor in the outlet vapors from the columns will be determined, other conditions remaining the same, by the number of fractionating plates in the column and the vapor temperature. The oil vapor saturation of outlet vapors is dependent upon the nature of the vapors leaving the last fractionation tray, their percentage and degree of volatility. When the temperature becomes lower than the average weighted boiling points of the mixture condensation will take place. Latent heat of condensation must be taken away by cooling, so the condensor must be sufficient both for cooling to the partial condensation stage necessary and for conveying away the latent heat. This is true of any condensing system.

As has already been stated the total pressures of a mixed gas is made up of the partial pressures of the constituents which are relative to the proportion by volume of each constituent present. In this case the total pressure is that of operation taken as π.

When the partial pressure exerted on any constituent is greater than its vapor pressure for the corresponding temperature in the pure state, condensation takes place until equilibrium is again established. In so doing a liquid phase is formed which has its absorption effects on other constituents present. It is well to know what percentage of oil vapor could pass the partial condensor at the top of the column. A fair idea is obtained by considering the outlet vapors as a two component system, the oil as the heavy and all other vapors as the light component. For this purpose the first five per cent of the absorption by distillation is taken to construct a temperature vapor pressure curve. This is only a fair approximation but gives good values in practice. At a point on the curve corresponding to fractionator vapor outlet temperature read the vapor pressure. The procedure is as before for finding the mol per cent that could be carried over with the vapors on the feed plates. It is again a molar per cent function of liquid and gas vapor pressures.

PLATES

In the rectification of a mixed liquid such as the one under discussion, the smallest amount of heat and temperature requirements for a given degree of separation are for a great number of successive re-distillations of distillates rather than for repeated distillation and reflux over the main body of oil. In the examples used for illustration, oil has been pictured as coming on to a feed plate which is the top stripping plate from which it gives off a distillate consisting of lighter vapors to a succession of fractionating trays above. Conditions extant within vapor and liquid phases have been correlated by use of mol units applicable to both absorbed and absorbent. These same units are used again in the computation of plate efficiency as the mol ratios of constituents have already been established by the conditions on the feed plate. Hawsbrand, in his classic work on fractional distillation proves by experimentation and mathematical analysis that for a

given amount of material separated from a mixture by fractionation less heat is required by the columns with the greatest number of plates. However, he does not use the mol unit in his computations directly, therefore they are more difficult of application to mixtures other than binary. Fortunately for purposes of rectification the chemical and physical natures of the hydrocarbons that constitute oil and natural gas are closely related.

The number of actual plates in a column is determined by the rated plate efficiency divided into the number of theoretically perfect plates required. The number of theoretically perfect plates required for a certain degree of separation is determined by reflux and equilibria conditions by a graphic method of integration using a modification of the McCabe-Thiele diagram.

The subject of tower design based on this and other considerations will be taken up in a subsequent article. It is necessary to establish a sound theoretical background upon which to base calculations for the most efficient design and operation of fractionating columns as applied to absorption plants.

Gasoline Plant Methods At Oklahoma City

(*Continued from page 72*)

These plants are designed not only to permit future expansion as they are now operated but also so that they may be readily adapted to any form of gas lift or gasoline plant operation. In the event of field pressures becoming lowered below plant operating pressures the low-stage compressors can be employed to boost field pressure to that required for efficient absorption, and the high stage compression equipment employed for increasing pressures to that required by field and gas lift lines. They are designed so that all departments such as the line of absorbers, the compressor buildings, boiler batteries, water cooling facilities, and the like, may be easily enlarged to take care of any necessary expansion.

Most of the plants are operated with steam turbine driven centrifugal pumps, working three pumps on the single shaft and securing a nicely balance rich and lean oil circulation as well as cooling water. Some plants are handled with duplex steam pumping equipment, others with electric motor driven centrifugals. The trend here and in other districts is toward the use of one motive power actuating a series of pumps, all of which are under full automatic control as to volume of fluid distributed to the various departments.

There are seven operators in the field at the present time. The old Foster Petroleum Corporation, now Indian Territory Illuminating Oil Company, was first to enter the field with a natural gasoline plant, using a 20,000-gallon Tulsa Type absorption plant and three 190 horsepower engines as primary equipment. Coline Gasoline Corporation followed with the second plant and was well along with construction before Coline Oil Company completed its first well. The original installation was a Southwestern type 85 plant. This unit, including cooling tower, boilers, and pumping equipment and the like, was arranged to permit the installation of two additional complete units, which enlargement soon followed and this plant now consists of four absorbers and two complete distillation units.

Coline Gasoline Corporation is one of the few operators in the field to act upon the advisability of completely housing its distillation facilities and its heating and control equipment working in connection with the high pressure fractionating plant. Incidentally several other plants are provided with high pressure stabilizing plants in this area. The Coline plant is designed for extreme flexibility and convenience of operation. Through careful design of manifolds practically any department or piece of equipment, such as mist extracting scrubbers, absorbers, distillation units, and the like, may be taken out of service for repair or cleaning without seriously impairing the efficiency of the plant. The compression plant originally consisted of five Type 80 Cooper machines with two more being added in June, and with sufficient space in the original building for 10 machines. Plant site space is provided for another similar 10-unit plant.

Two dehydrators are provided to operate between the evaporator and rectifying column and any water accumulating in the bubble trays of the column and passing through these dehydrators is automatically removed from the system. Steam traps are provided at the evaporator, steam preheater and receiving tanks for the removal of water. Water cooled oil coolers connected in series but so arranged that cooling water passes through the coolers in parallel, allows one of the coolers to be cut out of the system without shutting the plant down. A mist extractor handles gas from the fractionating column and removes water from these vapors before they go to the condenser equipment. The Coline plant is to install

a continuous sodium plumbite (Doctor) treating system to sweeten its gasoline production.

Practically all of the gasoline produced by the 14 Oklahoma City plants is slightly sour to the doctor test. This necessitates the installation of treating systems for sweetening of the production. For the most part the operators employ sodium hypochlorite solution as a treating agent, although one operator employes calcium hypochlorite solution followed by fuller's earth filtration. Again, the doctor treating method is employed, although it is a little more expensive than the sodium hypochlorite treatment.

Where the sodium hypochlorite treatment is employed the treating system consists of one treating drum and a small centrifugal pump for charging gasoline to the treater. Some drums are tile packed, others are baffled, others hollow. The auxiliary equipment consists of a mixing tank and a blow case. The treatment is very simple and inexpensive.

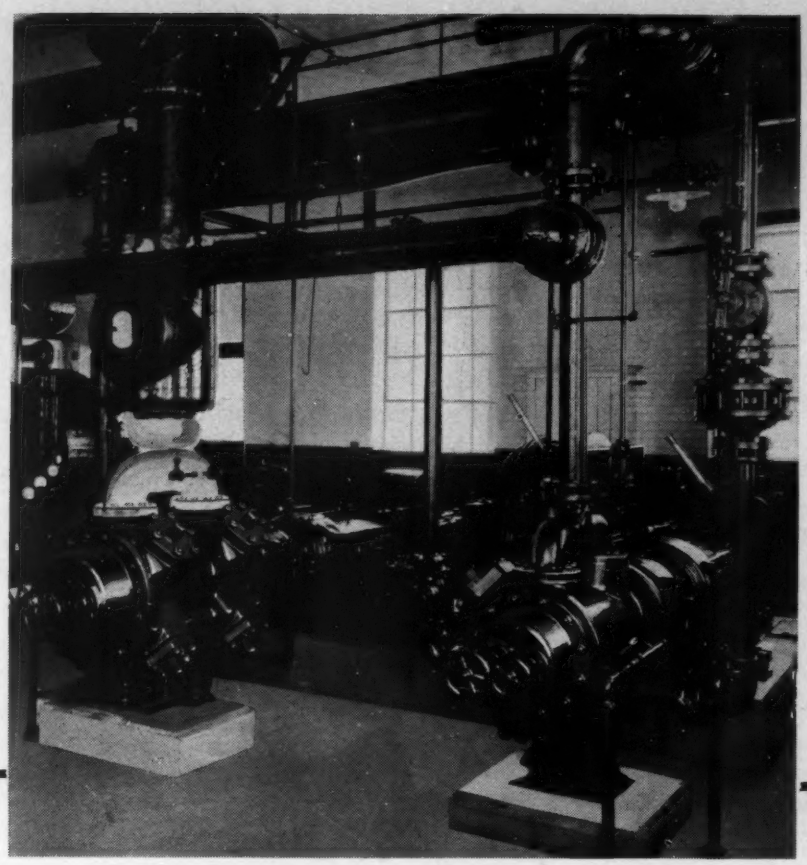
At one plant the treating tower is 18 feet in height and 26 inches in diameter. The lower part of the steel tower is protected with a four-inch layer of concrete, and the upper section is protected with a two-inch coating of concrete inside of the drum. This adds materially to the life of the vessel. In the bottom of the tower there is a distributing spider or spraying device through which the gasoline enters the drum to rise upward through the reagent. Two or three holes are spaced in each of the four arms of the spider and these holes are faced downward toward the bottom of the treating column. They are either ¼-inch or ⅜-inch in diameter. The number and size of these nozzles is governed by the size of the treating column and the volume of gasoline to be treated per hour. At this plant a level of 13 feet of sodium hypochlorite is carried, with five feet of gasoline above it and overflowing out of the top. Changing the size of the perforations in the arms of the spider experimentally was found to influence the efficiency of the treatment to a marked degree.

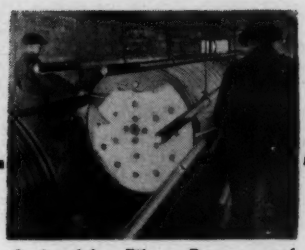
Some plant operators are using 15° caustic solution for chlorination, others 20° caustic and some weaker solutions. The practice of rechlorination spent solution differs with various chemists in the field, and where one plant treats 1,000 gallons of gasoline per pound of chlorine used and does not rechlorinate the spent solution, another plant is chlorinating the same batch of caustic twice in securing an extra 400 gallons treated per pound of chlorine used. Still another operator reports 1400 to 1600 gallons of gasoline per pound of chlorine without rechlorination but uses a stronger solution of caustic. It is probable that these minor differences in results may be attributed to a slight difference in the degree of oxidation necessary to sweeten the different grades of gasoline secured from gas from various sections of the field. The treatment in general is so inexpensive as compared to treating problems which are actually difficult that little need for experimentation is indicated. Several of the plants are delivering gasoline on contracts which do not specify that it shall be Doctor sweet.

Considering the Oklahoma City field in general, conditions of gasoline manufacture are not difficult to deal with. The high pressures encountered probably call for higher pressure plants in the event this unusual rock pressure is a permanent condition, which in itself would be unusual in this area. Certainly the reduction of 2000 pounds pressure to 40 pounds and recompressing to 175 to 350 pounds, is an uneconomic practie at the present time. If field pressure is eventually lowered to present operating pressure or lower, the present low pressure plants with lesser expensive costs involved are to be the logical means of handling the situation.

TEXAS COMMITTEE ASSEMBLING IMPORTANT FACTS

THE Joint Committee of Producers and Pipe Lines of Texas, of which David Donoghue has been appointed technical advisor, has opened offices in suite 1116 Fort Worth National Bank Building, Fort Worth, Texas. In addition to gathering information by questionnaire on pertinent facts pertaining to the supply and demand situation, the committee will gather field development and production on every producing area of Texas, as well as data on refinery operations and crude requirements. Mr. Donoghue has already laid the ground-work for a most complete store of valuable information that will undoubtedly prove of benefit in working out a solution to the over-production problem of this state. H. J. Struth, Staff Economist of The Refiner and Natural Gasoline Manufacturer, who is a member of this committee, spent a day with Mr. Donoghue recently discussing various phases of the work involved in gathering and presenting the necessary information in connection with the committee's work. Other members of this committee are W. N. Finnegan, statistician, the Humble Oil & Refining Company, Houston; Floyd Dodson, San Angelo; and Earl Calloway, Amarillo. Mr. Donoghue has urgently requested the cooperation of all Texas refiners, as well as producers and pipe line companies, so that he will be in a position to furnish the Texas Railroad Commission, and others involved, a complete and unbiased picture of the economic situation in Texas.





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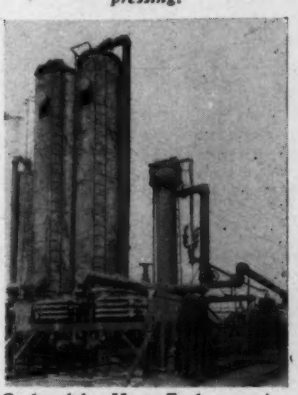

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Carbondale Refrigeration
CARMACO *for Refiners*

Method of Determining Gasoline Production Costs

(*Continued from page 110*)

included directly in Cost of Gasoline Produced, rather than by way of an expense ledger account, thus eliminating involved and complicated calculations. It is a loss only in quantity—not in volume, for undoubtedly, some of the oil charged into the stills was converted into gas and consumed. So the quantity shown as "Loss in Refining" is the difference between the sum of Gasoline and Fuel Oil known to have been produced, and the quantity known to have been "Consumed in Operations."

The details of the operating expenses shown on this Schedule may be further exhibited, if the management so desires, for, as mentioned in a previous paragraph, provision is made in the chart of accounts to record the items in the subsidiary expense ledger by operations.

In Schedule III, "Income, Profit and Loss," is reflected the Gross Profit from Operations, as well as the net profit for the month.

The first section, "Sales Revenue," is a summary of sales from invoice register. Consideration would, of course, be given at this point for any returns and allowances.

Cost of Sales, by individual products is from ledger accounts, and is also included in Schedule I, Summary of Operations. Inasmuch as it is not of particular importance to know the cost of gasoline sold, with which natural gasoline has been blended, there is included herein the quantity and value of natural gasoline so used.

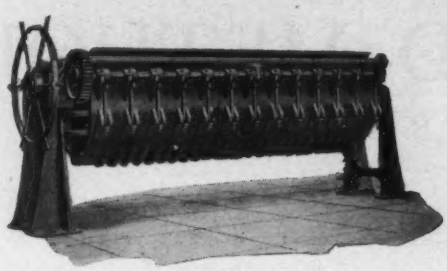
Amount of Tank Car Mileage Earned is treated as additional income, and not included as a deduction in expenses, as is done in some methods. The reason is that it is considered that the amount paid as Tank Car Rental as a part of Selling Expense, representing a known expenditure, and which expense is essential to the delivery of finished products from the refinery. Therefore, any amount recovered, so to speak, of this expense, should be treated as done here, for the amount of this revenue varies in accordance with the greater or lesser distance the car travels on its mission of delivery.

If the data contained in these three schedules is given due thought and consideration by all concerned in the operation of the plant, there can be no "guessing" as to what the cost of manufacturing is. The more we all know of such situations, the better able we are all going to be to cope intelligently with the problem of deciding whether it is best to continue to operate, or close down during the periods of depression and uncertainty.

INCOME, PROFIT and LOSS. Schedule III

	Barrels	Unit Price	Amount	Total
Sales Revenue:				
Crude Oil	1,000	$1.75	$1,750.00	
Fuel Oil	9,000	.90	8,100.00	
Gasoline	20,000	2.94	58,800.00	
				$67,650.00
Cost of Sales and Expenses:				
Cost of Sales:				
Crude Oil	1,000	1.50	1,500.00	
Fuel Oil	9,000	.90	8,100.00	
Gasoline	20,000	2.38+	47,720.50	
Natural Gasoline (Used in Blending)	450	3.28	1,476.60	
			58,797.10	
Expenses:				
Selling			1,600.00	
Administrative			4,300.00	
Taxes			300.00	
Total Cost of Sales and Expenses			64,997.10	64997.10
Gross Profit From Operations				2652.90
Other Income:				
Tank Car Milage Earned			1,500.00	
Sundry Rents			250.00	1750.00
				4402.90
Other Deductions;				
Depreciation				2700.00
NET PROFIT				$1702.90

Devised by R.E.Kerfoot



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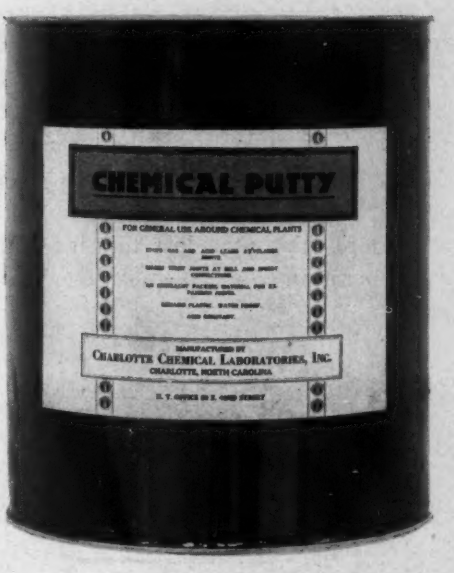

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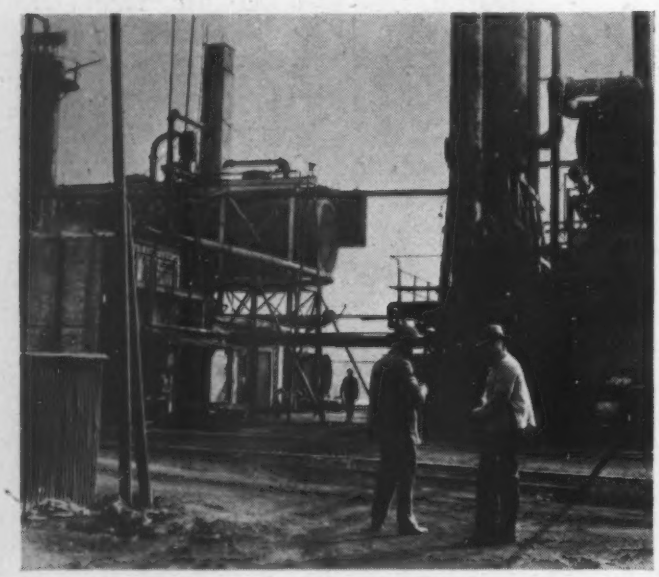
PLANT MEN AND METHODS

By GEORGE REID

PURE Oil News, that excellent house-organ of The Pure Oil Company, edited and diligently cared for by genial Chas. A. (Pat) Ward in the issue of July carries a safety note from the Ardmore, Oklahoma, refinery written by correspondent "S.C.B." (who, we see from the title page, is S. C. Bigham) that merits repetition.

After speaking of a number of things S.C.B. writes, "Among numerous things that have been done and are being done in the interest of safety, the acetylene generator has been stockaded with old heavy steel cracker tubes to protect the men about the shop in case the generator should explode, or to protect the generator in case the men should drink the carbide.

"After holding another good safety meeting and inspecting our rabbit's foot, we started on the tenth consecutive month without a lost time accident and good safety cooperation and the rabbit's foot are still working."



W. D. Manz on his plant yard

SINCE the Ashland Refining Company, Ashland, Kentucky, and Tri-State Refining Company, Kenova, West Virginia, have merged W. D. Manz, superintendent of the Tri-State refinery (shown in the photo with the sweater) has been busy enlarging the crude capacity of his plant. Part of the crude and redistillation equipment is shown in the background.

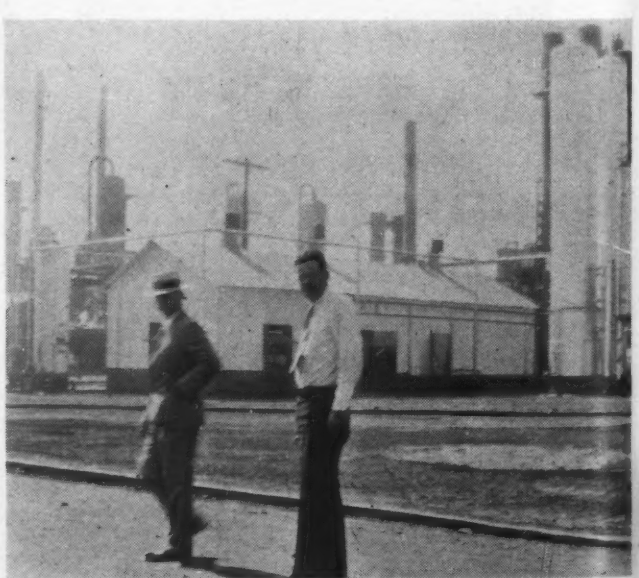
Mr. Manz engages in inter-state commerce when he charges stills at his plant, which is an unusual condition in refining. The Tri-State tank farm is located high upon the hills across the river in Kentucky and is transported by pipe line across the river to the tube stills at the plant in West Virginia. The plant consists of tube stills, rerun tube stills, and a Jenkins cracking unit. A detailed discussion of the plant operation appeared in this magaazine in December, 1929, page 82.

Since the merger of Ashland Refining Company and Tri-State Refining Company no change has been made in company names excepting that the original Tri-State organization chartered in Nevada has been taken over by the newly formed company styled Tri-State Refinnig Company of West Virginia.

Mr. Manz, in addition to refinery superintendent, is a petroleum chemist and held that position with the company before his promotion to his present position. He is also a Councillor in the Division of Fire Prevention and Safety of the National Petroleum Association.

DURING the past year Fred N. Williams, general superintendent of refineries for Simms Oil Company, Dallas, (the gentleman without the coat) has been one of the busiest plant managers in these parts. With everything in shape, a remodeled refinery running with enviable efficiency, and a new paint job on most of the equipment, Superintendent Williams is finding time to show visiting friends around the works.

The writer was lucky, for I. H. Lantz, superin-



Fred N. Williams and J. H. Lantz

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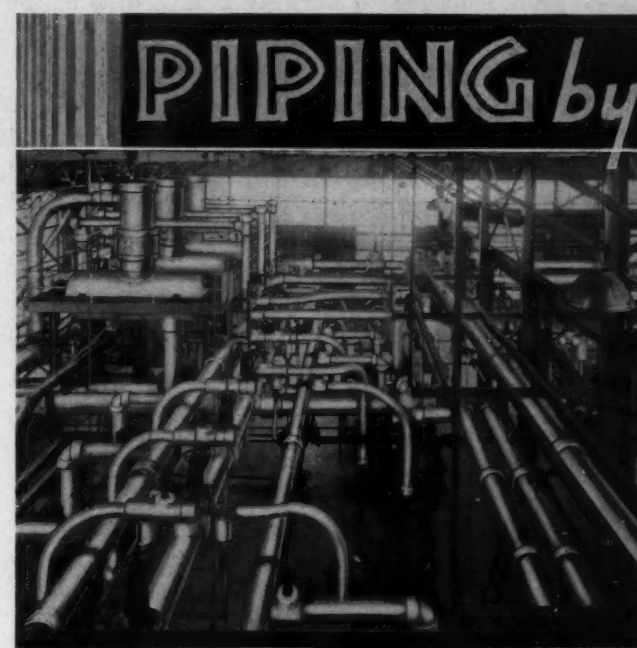
Industrial Cleaning Materials and Methods



Refineries are exacting

To meet the ever-increasing requirements of this rapidly growing industry and to keep pace with the latest scientific achievements, refineries require the most modern equipment and give strict attention to maintenance and upkeep. Their demands are exacting—but it is a tribute to this organization that "POWER PIPING" has met their needs efficiently and economically through the years!

POWER PIPING COMPANY
PITTSBURGH, PA.

FROM A MERE FITTING
TO A COMPLETE SYSTEM

tendent of the Smackover, Arkansas, refinery, was visiting the Dallas plant. He is shown in the photo trying to escape the lense. O. Mingus, superintendent of the Dallas plant managed to keep at a safe distance or "around some corner."

Mr. Williams has pioneered in the debutanization or degasification of gasoline produced by cracking, rather than degasifying pressure distillate. The economies and advantages of such a system are presented in a special article appearing in this issue. We are deeply indebted to Simms Oil Company, and Mr. Williams and his assistants for their permission to present the details of construction and operation of this system and for their whole hearted cooperation in the preparation of the writing.

AND now comes word that the refinery industry has pilfered another process and appropriated another system, adapting it with modifications to the needs of chemical refinement processes. The industry admits borrowing the bubble tower and fractionation data from the alcohol industry, acid treating from the old time coal-oil refineries of pre-petroleum days, and now through a devious route it has taken contact filtration from the Chinamen.

John A. Millif, Sunset Pacific Oil Company, Los Angeles, California, in his paper read before the California Natural Gasoline Association, "Lube Oil Manufacture From Drake Down to Date" gives credit to the Chinese as the earliest users of contact filtration. He says, "There has been much discussion as to where the contact process originated, but it is well known that this method of filtration has been known to the Chinese for hundreds of years, and used by them in clarifying their vegetable oils. It was later introduced in this country by one of the large soap companies and gradually found its way into the oil industry."

So it appears that in addition to fish hooks, printing presses, fire-works and good laundering the Chinamen have known a thing or two about contact filtration along with their knowledge of natural gas pipe lines via hollow bamboo poles for perhaps quite a few centuries before the original American refiner.

Group photo taken upon completion of construction of the new refinery owned and operated by Nacogdoches Refinery, Inc. at Nacogdoches, Texas. Neil F. Blaine, vice-president, in charge of operation is shown in the front row, seated, sixth from the left, and A. V. Raplee, president, is seated at his right.

Team Work Gets Cracking Units Back On Stream

(*Continued from page* 116)

present method is to use all the fire that can be put through the furnace without burning up the smokestack. The operators report that the result is that they get on stream with far less coke in the tubes than they ever had under the old method.

In their effort to reduce clean-out time the operators formerly endeavored to cut the cooling time to a minimum, but they have found that time could be saved by doing just a little more cooling, particularly just previous to scaling the chamber walls and hanging the cable and still further reduce their clean-out time. The reason for this saving being, of course, that the men could not stay in the chamber long enough when it is too hot, and it requires considerable time to bring one gang out of the chamber and send another one in. Under the present scheme one gang of men does the job.

The bonus system has proven highly satisfactory at this plant and might be said to be almost fool proof. If the crew is inclined to do careless work which might result in a leak when the plant is tested the crew learns immediately that their careless work has cost them a bonus for that clean-out, since the bonus is figured on the basis of time between streams. Similarly, they realize that if the cable is carelessly hung or insufficiently supported there will be no bonus on the following clean-out, due to the dropping of the cable and the attendant difficulties in cleaning the chamber. It has been the experience of the operating personnel during the year or more that the bonus system has been in vogue that they have experienced much fewer leaks and secured a much better class of workmanship throughout.

F. W. Irwin, superintendent, states that up to June 1, the unit operators have not participated in the clean-out bonus. However, the company expects to pay them a bonus in the future on exceptionally short clean-out periods. Such bonuses would run, for example, $1.00 per man for anything between 13 and 14 hours, $2.00 per man for clean-outs running from 12 to 13 hours, and $3.00 per man for 11 to 12 hour periods from stream to stream. Likewise the clean-out men may be paid an additional bonus for anything under 14 hours, which bonus will probably run 50 cents per man per hour.

During March when the record of 10 hours and 55 minutes from stream to stream was made, the previous record was broken four times. The average stream to stream time for 11 clean-outs during March was 15 hours and 13 minutes, which includes one clean-out of 16 hours during which furnace repairs were made and another cleanout period of 22 hours during which five tubes were replaced.

Determination of Lead Tetraethyl in Gasoline

By L. J. CATLIN and J. E. STARRETT
The Standard Oil Company (Kansas)

THE widespread use of ethyl gasoline is bringing to the laboratory a demand for methods of determining by analysis the amount of lead tetraethyl in the gasoline as marketed. Ethyl Gasoline Corporation and others responsible for marketing are keeping close check on all shipments from blending stations by means of samples sent to their own laboratories, but control at the source is also necessary. By recommendation of the United States Public Health Service the amount of Pb $(C_2H_5)_4$ in gasoline has been limited to a maximum of 1 part in 1300, which is equivalent to about 3 cc. per United States gallon. Ethyl fluid as marketed at the present time is about 58.37 per cent $PbEt_4$ by weight and has a specific gravity of 1.74. One cc of pure $PbEt_4$ weighs 1.62 and contains 1.0368 g. Pb. The composition of Ethyl fluid may be changed from time to time but the amount of lead tetraethyl in the gasoline will be the final test of importance.

The method here offered has been checked against known additions of lead tetraethyl, and also against reports from other laboratories on identical samples with satisfactory results. Others may be using the same principles in testing, but so far as we know they have not been published. The general principle is precipitation of lead with bromine, converting to the acetate, and titrating with ammonium molybdate. Direct conversion to the acetate, however, does not permit separation from the hydrobromic acid thus produced and this interferes with the molybdate titration. Concentration with sulphuric acid drives off all volatile acids and leaves a precipitate which can be washed clean for further testing.

Reagents — Ten per cent solution of bromine in carbon tetrachloride; carbon disulphide; fifteen per cent nitric acid solution; concentrated sulphuric acid; ammonium acetate, prepared as follows: water 125 cc., glacial acetic acid 100 cc., ammonia water (28 per cent NH_3) 95 cc., ammonium molybdate, C.P., 8.67 gms. in 1 liter water. 1 cc equals .01 gm Pb; tannin, freshly prepared, about .1 g. in 20 cc water.

The test: Protect the sample from evaporation as much as possible in handling. Measure accurately 100 cc ethyl gasoline into a 250 erlenmeyer flask and add bromine solution drop by drop with constant stirring till the precipitate settles readily. For straight run gasoline about 10 cc as required, and for cracked gasoline perhaps 20 to 30 cc. Let stand a few minutes and add five cc excess, noting whether more precipitate forms.

After about five minutes settling pour off the gasoline carefully through a filter, leaving as much of the precipitate as possible in the flask. The filtrate may be tested with additional bromine solution for complete precipitation of lead. The precipitate in the flask is washed free from gasoline by two washes of about 25 cc carbon disulphide, decanting carefully through the filter to wash any precipitate deposited there. Allow a few minutes for evaporation of carbon disulphide from the precipitate, which may be aided by a mild current of air.

Heat to boiling point about 30 cc nitric acid solution and pour through the filter paper to dissolve that portion of the precipitate, catching it in the flask with the main portion. The filter paper may be punctured to facilitate this transfer. Finally wash filter with boiling water.

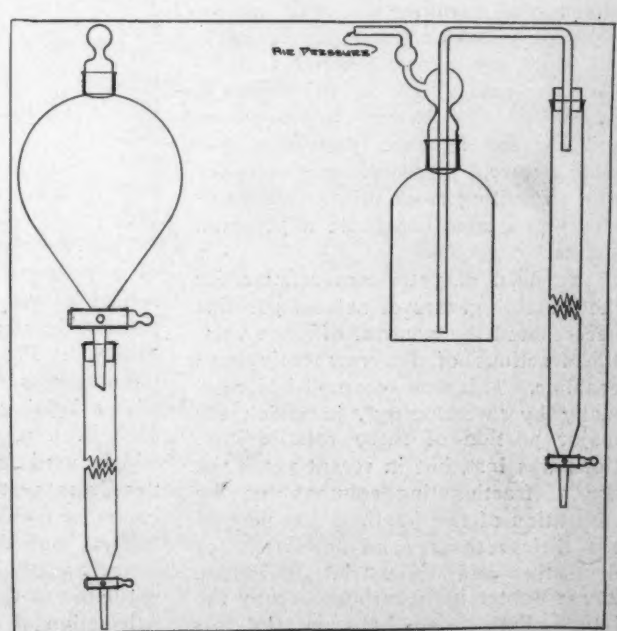
Add cautiously about five cc concentrated sulphuric acid and boil till dense fumes of H_2SO_4 appear, driving out all nitric acid and bromine. Dilute with about 25 cc water and allow lead sulphate to settle. Decant through a clean filter and finally wash with at least two washings of 15 to 20 cc water to remove excess acid.

Wash precipitate from filter into flask containing main portion, with about 15 cc boiling ammonium acetate, and boil till all lead sulphate is dissolved.

Titrate while hot with standard ammonium molybdate, using tannin on a spot plate as outside indicator. The appearance of a yellow color when a drop of tannin is touched with a drop from the sample being titrated indicates the end point.

The number of cc. molybdate used times .37 equals cc $PbEt_4$ per United States gallon gasoline.

Bromine solution being disagreeable and irritating, may be handled in a separatory funnel or wash bottle as shown in the accompanying sketch.



Apparatus used in the tests

Liquified Petroleum Gases

By E. B. SWANSON
Acting Chief Economist
Division of Petroleum Economics, Bureau of Mines, June 24, 1930

MARKETED production of liquefied petroleum gases during 1929 reached a total of 9,925,698 gallons, an increase of 120 per cent over the 4,522,899 gallons marketed during 1928, according to the United States Bureau of Mines, Department of Commerce, following the completion of a survey conducted by E. B. Swanson, Acting Chief Petroleum Economist, through which the first quantitative data on this recent development in the petroleum industry have been assembled. Information received from representative producers regarding shipments during the first five months of 1930 indicates that the rate of growth established during 1929 is being continued. Of the 1929 distribution, 113,080 gallons were shipped outside the United States, principally to Canada and the Hawaiian Islands.

The production of Pintsch gas, a compressed gas made by cracking oil and used principally as an illuminant; the manufacture of Blaugas, a liquefied petroleum gas made from gas oil; and the extraction and liquefaction on a relatively small scale of some of the lighter fractions of casinghead gasoline, constitute a background, extending over approximately half a century, for the recent developments in the commercial manufacture and sale of liquefied petroleum gases. In the present stage, the natural gasoline extracted from natural gas is the principal source of the lighter hydrocarbons suitable for liquefied petroleum gas manufacture, although the refinery gases resulting from various oil distillation processes constitute a potential source.

The need of petroleum refiners for more stable grades of natural gasoline necessitated the removal of more volatile fractions of the raw casinghead gasoline. This was accomplished originally by "weathering", in which the major portion of these volatile fractions was lost, but in recent years the use of fractionating columns for the separation of the fractions has permitted their recovery and utilization for domestic and industrial purposes. These lighter hydrocarbons occupy the intermediate zone between the so-called permanent gases and liquids. They remain in liquid form when under pressure but are gases at atmospheric pressure and normal temperatures. Consequently, they may be stored and transported as liquids under pressure in special cars, tanks, wagons, and cylinders and used as gases at atmospheric pressure. Propane and the butanes form the compounds in the liquefied petroleum gases now definitely established, but pentane, a liquid at average temperatures, was included in the survey to the extent that it is marketed for purposes similar to the two lighter fractions.

Growth of Market

The record of the production of liquefied petroleum gases may be extended as far back as 1912, when Blaugas was established as a commercial product, but, as such a record would in part indicate the operations of individual companies, the record of marketed production is extended only through 1922, the period during which three or more companies were annually engaged. The annual marketed production of liquefied petroleum gases is given in the following table:

Marketed Production of Liquefied Petroleum Gases
(1922-1929)

Year	Gallons
1922	222,641
1923	276,863
1924	376,488
1925	403,674
1926	465,085
1927	1,091,005
1928	4,522,899
1929	9,925,698

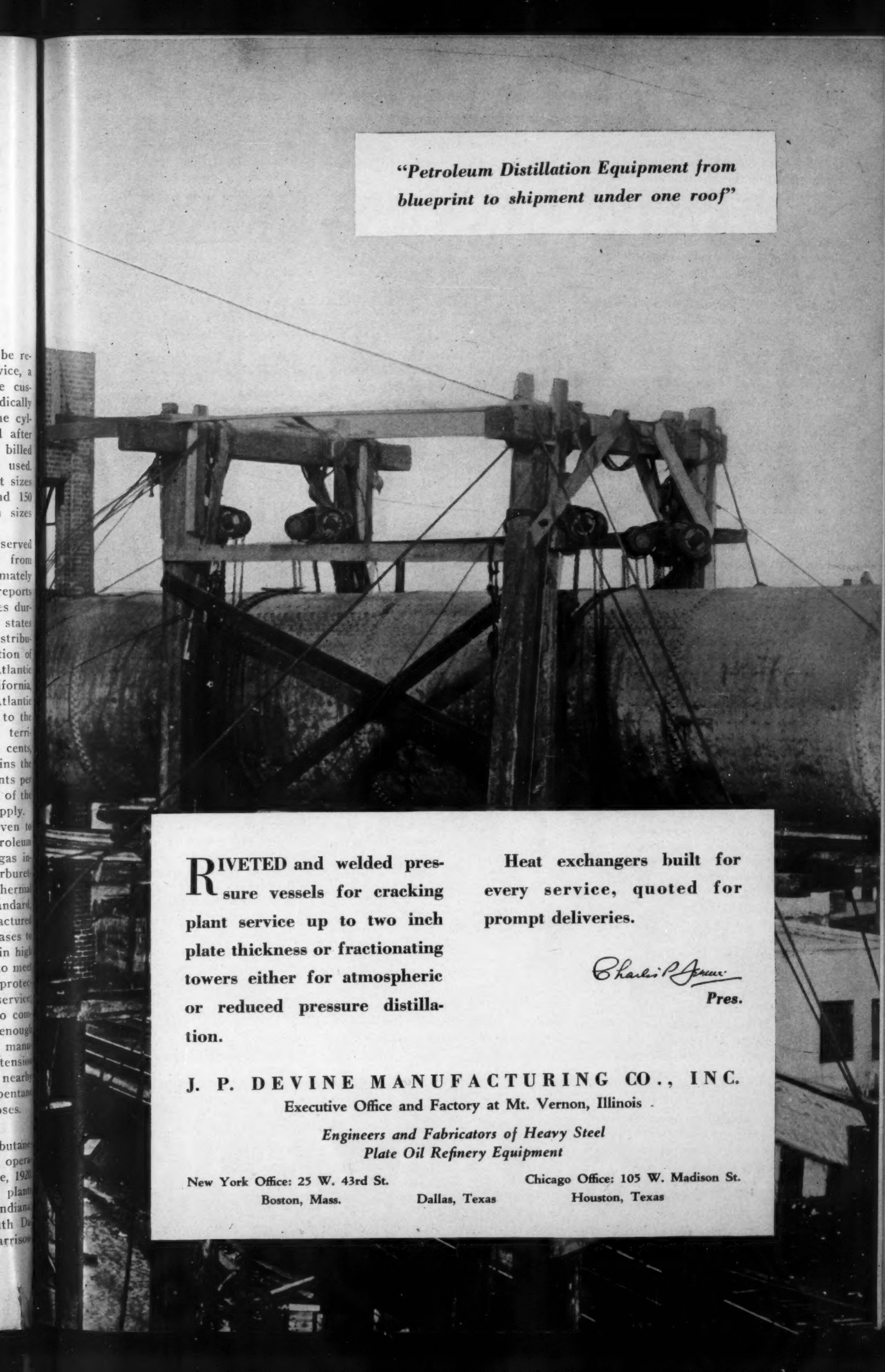
The use of liquefied petroleum gas as a domestic fuel in territories not served by gas mains was the first important development in the use of the products. Propane, self-vaporizing at temperatures above minus 44°F. and with a heating value of approximately 2500 B. t. u. per cubic foot, is most widely used for this purpose. In the two-drum system of service, two cylinders of fuel are installed in a special cabinet outside the customer's residence and the gas is piped through a regulator to the appliances. Upon the exhaustion of one cylinder, the second is turned on and the empty cylinder is returned to the bulk station to be recharged. In the one-drum service, a single cylinder is furnished the customer. This cylinder is periodically charged from a service truck, the cylinder being weighed before and after charging, and the customer is billed for the actual amount of fuel used. Cylinders are of several different sizes —25, 35, 40, 50, 60, 88, 100 and 150 pounds—but the more common sizes are 60 and 100 pounds.

The number of customers served with "bottled gas" increased from about 20,000 in 1928 to approximately 55,000 in 1929, according to the reports submitted to the Bureau of Mines during the survey. Although all states were included in the national distribution of this fuel, the major portion of consumers were in the North Atlantic and North Central States, California, and the Southern States of the Atlantic seaboard. The price per pound to the consumer in the Pacific Coast territory ranged from 9.5 to 10.5 cents, while east of the Rocky Mountains the price ranged from 11.3 to 14.5 cents per pound, according to the distance of the consumer from the source of supply.

Special attention has been given to the utilization of liquefied petroleum gases in conjunction with the gas industry; to replace gas oil in carburetting gases of relatively low thermal value to the required calorific standard, as a base material for manufactured gas; for the re-carburetion of gases to offset the loss of thermal value in high pressure transmission systems; to meet peak load conditions and as a protection against interruptions in service, and as a source of gas supply to communities which are not large enough to warrant the installation of manufactured gas plants or the extension of distribution systems from nearby centers. Propane, butane and pentane have been used for these purposes.

Carburetion

The first plant employing the butane-air carburetion process began operations at Linton, Indiana, in June, 1928. By the close of 1929, similar plants were operating in Sheridan, Indiana; Calais, Maine; Watertown, South Dakota; Mapletown, Iowa; Harrison



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burg, Virginia; North Manchester, Indiana, and Moorpark, California. At the end of May, 1930, additional plants were operating in Shenandoah, Iowa; Cleveland, Tennessee; Kerrville, Texas; Hendersonville, North Carolina; Sheldon, Iowa; Harrisburg, Illinois, and Chadron, Nebraska; while similar plants were under construction in Clarinda, Iowa; Columbia, Tennessee; Maryville, Tennessee; Eldorado, Illinois; Murfreesboro, Tennessee; Onset, Massachusetts; Maryville, Missouri; Goodland, Kansas; Missouri Valley, Iowa; Bath, Maine; Moultrie, Georgia; Bemidji, Minnesota, and Chisholm, Minnesota. Plans for the extension of similar service to a number of communities in California have been announced. The experience gained in piping propane-vapor to small groups of houses has been applied to distribution systems for communities which are not suitable for the profitable operation of butane-air carburetion plants.

Other Uses

Liquefied petroleum gases also have been applied to a number of industrial purposes. Several industrial plants have installed butane storage equipment as a standby to guard against the interruption of their normal fuel supply. Propane is being used as a fuel to heat the adsorbers in iceless automatic refrigeration cars and its use in a somewhat similar way for cooling railroad passenger cars has been suggested. In the metal and allied industries, liquefied gases are being used for heat treating, hardening, annealing, gas carburizing, enameling, core baking, metal cutting, forging and similar operations. In commercial laundries, these gases are used for operating collar and cuff pressing machines, mangles, hand irons and washing machines, while in the food industries, they have been applied to the canning of milk, fruits and vegetables and the roasting of coffee and peanuts.

Producers and Distributors

This list of producers and distributors of liquefied petroleum gases was compiled from data submitted to the Bureau of Mines, in connection with the survey of the marketed production of these gases. The first part of the list includes the companies which, wholly or in part, market liquefied petroleum gases of their own manufacture while the second part includes the companies which market gases purchased from one or more of the manufacturing companies listed.

Part I—Producers

Bradford Gasoline Company,
Bradford, Pennsylvania. (See The Nugas Corporation, under distributors, for other data).

Carbide & Carbon Chemicals Corporation,
Carbide & Carbon Building, 30 East 42d Street, New York. Trade Name, "Pyrofax". Sale of product started in 1924. Territory served: All States. Branch offices in Boston, Chicago, Cleveland and San Francisco.

Hope Construction & Refining Company,
545 William Penn Way, Pittsburgh. Trade Name — "Hope Bu-Tane". Sale of product started January, 1920. Territory served: Pennsylvania, Ohio, New York, West Virginia, Indiana, Illinois, Minnesota, Michigan, and New Jersey.

Lone Star Gas Company,
1915 Wood Street, Dallas, Texas. Trade Name—"Stargas". Sale of product started July 1, 1929. Territory served: Texas.

The Mars Company,
Oil City, Pennsylvania. Sale of product started May 15, 1928. Territory served: Sells to distributors operating in Eastern States.

Philfuels Company,
7-101 General Motors Building, Detroit, Michigan. Trade Name—"Philgas", "Philfuel". Sale of product started in 1927. Territory served: Connecticut, Florida, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York, North Carolina, Ohio, Rhode Island, South Dakota, Virginia, Wisconsin, and Ontario, Canada.

Shell Oil Company,
Shell Building, San Francisco, California. Trade Name—"Shellane". Sale of product started August 1, 1929. Territory served: California, Arizona and Nevada.

Shell Petroleum Corporation,
13th and Locust Streets, St. Louis, Trade Name—"Shellane". Sale of product started January, 1929. Territory served: Minnesota, Wisconsin, Iowa, Illinois, Indiana, Michigan, Oklahoma and Texas. Branch offices in Chicago, Madison, Wisconsin, Austin, Minnesota, and Lansing, Michigan.

Skelly Oil Company,
El Dorado, Kansas. Trade Name—"Skelgas". Sale of product started May 19, 1928. Territory served: Arkansas, Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Oklahoma, and Wisconsin. Branch offices in Chicago, Des Moines, Kansas City, Minneapolis, Omaha, St. Louis, Tulsa.

The Sloan and Zook Company,
Kane, Pennsylvania. Sale of product started about 1916. Territory served: Wholesale distributor in Pennsylvania and Western New York.

Standard Gasoline Company,
225 Bush Street, San Francisco, California. (See Standard Oil Company of California, under distributors, for other data.)

Viking Gasoline Corporation,
Charleston , West Virginia. (See Viking Realty Company, under distributors, for other data).

Distributors

The Bluflame Gas & Range Company,
Toledo, Ohio. Sale of product started October, 1929. Other data not submitted.

Carolina Suburban Gas Company,
Greensboro, North Carolina. Trade Name—"Philgas". Sale of product started June, 1928. Territory served: North Carolina, Southern Virginia, and Northern South Carolina.

Citigas Corporation of New Jersey,
2931 Atlantic Avenue, Atlantic City, New Jersey. Trade Name—"Citigas". Sale of product started March 5, 1929. Territory served: Atlantic, Cape May, Cumberland, Salem, Gloucester and Camden Counties, New Jersey. Maintains four branch warehouses.

Delco Light Company,
Dayton, Ohio. Trade Name—"Delcogas". Sale of product started July 16, 1929. Territory served: All States east of the Rocky Mountains. Maintains six warehouses and 35 district offices.

*Economy Battled Gas Company,
Miami, Florida.

Fuelite Natural Gas Corporation,
705 Main Street, Waltham, Massachusetts. Trade Name—"Fuelite". Sale of product started 1924. Territory served: All of New England and part of New York. Branch office at 33 Dwight Street, Springfield, Massachusetts.

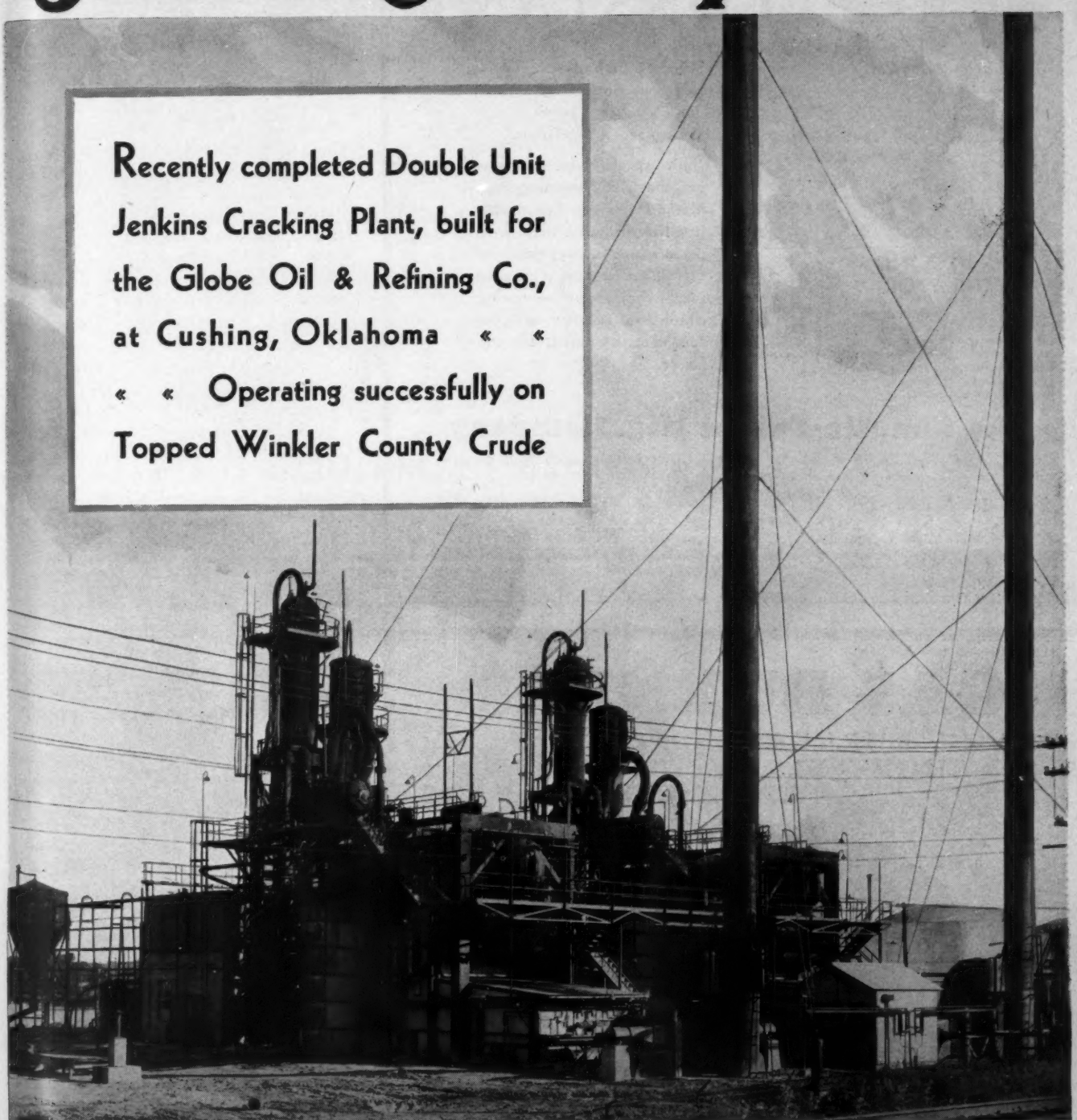
*Grand Rapids Welding Supply Company, Inc.,
Grand Rapids, Michigan.

*Hi-Heat Gas Company,
21 East 40th Street, New York.

Imperial Gas Company,
Long Beach, California. Trade Name—"Rockgas". Sale of product started November 25, 1925. Territory served: California, Oregon, Washington, Nevada, Arizona, New Mexico, British Columbia, and Hawaiian Islands.

Northwestern Blaugas Company,
Hampden Avenue and Charles Street, St. Paul, Minnesota. Trade Name—"Blaugas". Sale of product started July, 1921. Territory served: Min-

JENKINS CRACKING PROCESS



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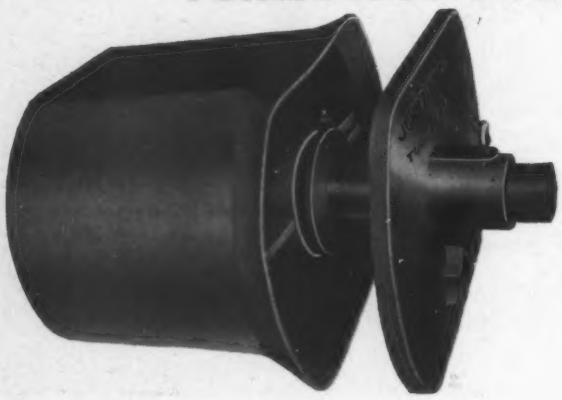

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nesota, Wisconsin, Illinois, North Dakota, South Dakota and Michigan.

The Nugas Corporation (Also Bradford Gasoline Company), Bradford, Pennsylvania. Trade Name—"Nugas". Sale of product started August 17, 1922. Territory served: New York, New Jersey, Pennsylvania, Connecticut, Massachusetts, New Hampshire, Vermont, Rhode Island, Maine, Georgia, Delaware, Maryland, and District of Columbia.

The Ohio Valley Oxygen Company, 946 Kenyon Avenue, Cincinnati, Ohio. Trade Name — "Philgas". Other data not submitted.

Omaha Blaugas Company, Inc., 28th and Boyd Streets, Omaha, Nebraska. Trade Name—"Blaugas". Sale of product started December, 1927. Territory served: Iowa, Nebraska, Kansas, Missouri, parts of Western Illinois and Eastern Colorado.

Pittsburgh Thermoline Company, 45 S. 20th Street, Pittsburgh. Trade Name—"Thermoline". Sale of product started 1918. Territory served: East of Mississippi River. Branch offices at Philadelphia, Cleveland, Greenwich, Connecticut, Indianapolis, and Chicago.

*The Protane Corporation, Erie, Pennsylvania.

*Rockgas Products Company, Pittsburgh, Pennsylvania.

Standard Oil Company of Califonia, 225 Bush Street, San Francisco. Trade Name—"Standard Flame". Sale of product started December 15, 1928. Territory served: California, Nevada, Arizona, and parts of Utah and Oregon.

Suburban Gas Company, Belleville, New Jersey. Trade Name —"Suburban Gas". Sale of product started January 1, 1929. Territory served: All of New Jersey, north of a line from Camden to Asbury Park, and Orange and Rockland Counties of New York.

Super-Fuel Company, 36th Street and 13th Avenue, Tampa, Florida. Trade Name—"Philgas". Sale of product started January 1, 1928. Territory served: Florida.

*Tirrill Gas Machine Corporation, 50 Church Street, New York, N. Y.

*Universal Bottled Gas Company, Rochester, N. Y.

*Vapyre Corporation, Pleasantville, N. Y.

Viking Realty Company, Charleston, West Virginia. Trade Name—"Tru-Gas". Sale of product started February 6, 1928. Territory served: Ohio.

*Data regarding operations not submitted.

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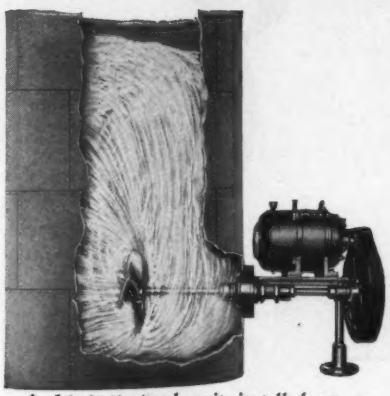

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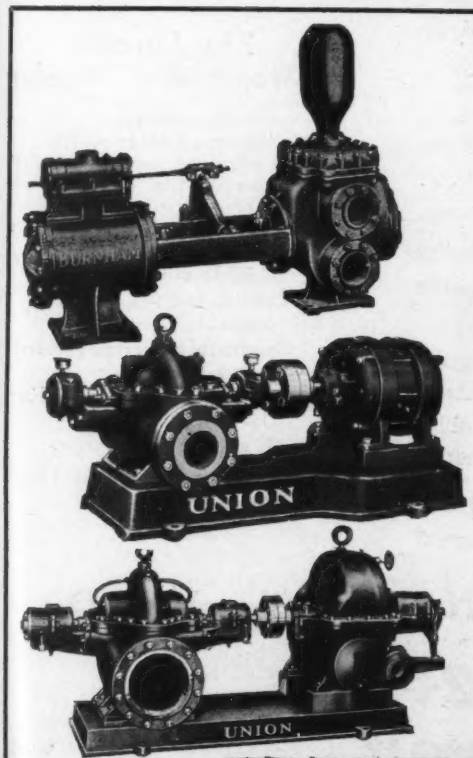

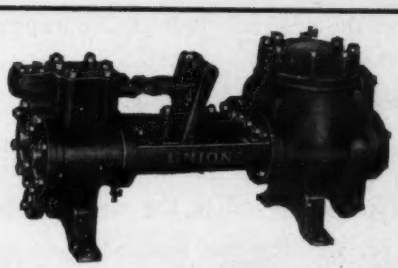

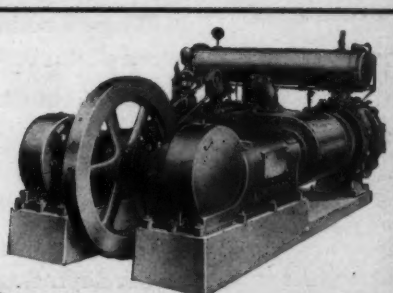

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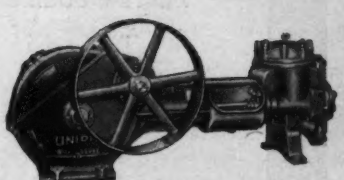

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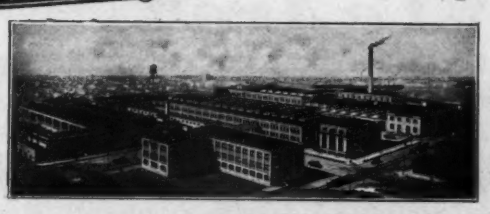

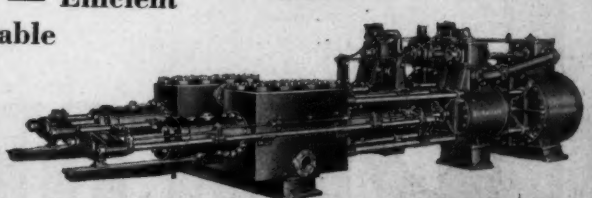

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One would imagine that the economies and improvements of the Specialist end with him . . . but these benefits go beyond him . . . to the welding machine . . . yes, even to the electrode he uses.

Lincoln's specialization on welding has enabled them to bring about developments which have put welding on a more profitable basis for the users. (See 'Stable-Arc' exclusive features).

This same specialization on welding by the Lincoln organization has also enabled them to give to industry not only better machines, 'Stable-Arcs'— but also superior electrodes, 'Fleetweld', 'Stable-Arc', 'New Kathode', 'Stainweld A', 'Lightweld' and 'Anode'.

That's a *double* triumph of the Specialist

—Chic and Double Chic, as it were."

The Lincoln "Stable-Arc" Welder

— welds easier
— makes better welds
— permits greater output

because of the steady uniform arc throughout entire welding range, which is the result of:

Variable voltage design
Laminated magnetic circuit
Separately-excited generator field
Double control of welding heat
All steel construction

No other welder has all these features.

The Lincoln Electric Co., Dept. No., 34-7 Cleveland, O.

W-151

LINCOLN "Stable-Arc" WELDER

Refinery and Gasoline Plant Activities

New Plants – Construction Notes – Personnel Changes

Altitude Moving Refinery

Altitude Petroleum Company, Tulsa, and Peveto & Peacock of Oklahoma City, have purchased the old skimming plant of the West Kansas Refining Company at Russell, Kansas. The plant was owned by George H. Siedhoff of Wichita, Kansas. It has been shut down for several years. The equipment is being dismantled and moved to Oklahoma City where it will again be placed in service.

Atlantic Dismantling Lewis Units

Atlantic Refining Company is dismantling the last of its old Lewis cracking units at its Point Breeze, Philadelphia refinery and a portion of the available space will be utilized by the construction of four De Florez units now under construction. Capacity of the new units is reported at 1000 barrels each. Operation is scheduled in January, 1931.

Barber Has New Laboratory

Barber Asphalt Company, at Maurer, New Jersey, has under construction a new three-story, 50 x 120 feet general laboratory and engineering building. Latest modern analytical equipment is to be installed.

Big Horn Building

Big Horn Oil & Gas Company is reported to have started construction of a refinery at Billings, Montana, to cost about $100,000. This is a newspaper report credited to J. D. Everett, president of the bulk distributing company, Associated Independent Dealers. The new plant is to be completed by early fall.

Black Gold Building Skimming Plant

Black Gold Refining Company has started construction of a skimming plant in the Oklahoma City field. Capacity is reported at 1000 barrels daily. Dan A. Corcoran is president of the company. The location is in Section 35-11-3w. The plant will have Santa Fe railway loading facilities. Mr. Corcoran, president, was formerly in charge of refineries for Wirt Franklin Petroleum Corporation.

Coltexo Completes Plant

Coltexo Corporation has started operating its third natural gasoline plant in Gray County, Texas. The rated capacity is 15,000 gallons daily. It is located 4½ miles east of Lefors near which town the company's two other Texas Panhandle gasoline plants are operating. Gasoline production of the Coltexo plants is piped to Hoover where it is shipped on the Santa Fe railroad.

Continental Filter Plant Completed

Continental Refining Company, Oil City, Pennsylvania, has completed construction of its new filter house which replaces the old filtration facilities destroyed by fire last July. Estimated cost is $150,000, the new plant being double the capacity of the former installation.

Continental to Produce Dry-Ice

Continental Oil Company and the Dry Ice Corporation of America, Inc., will form a new jointly owned company for the production of "dry ice." Arrangements are being concluded for the construction and operation of a plant for the production of carbon dioxide to be used as a refrigerant, the proposed unit to be located at the oil and gas properties of Continental Oil Company in the vicinity of Waldon, Colorado, utilizing the raw material produced from wells in that area. The plant will be equipped for an initial production of 60 tons per day, and is reported to cost $250,000 including equipment, according to an item appearing in Industrial and Engineering Chemistry, New Edition, June 20.

Continental Plans Denver Refinery

Continental Oil Company's new Denver refinery is to be a complete refining unit consisting of topping and cracking facilities, a vapor recovery unit and Ethyl blending equipment. Light products are to be removed through heat exchange in connection with the operation of the cracking plant, skimming and cracking in one operation. Gray vapor phase treating towers will be employed to treat the cracked vapors. The refinery is to be electrically operated with electric power purchased. Fort Collins, Colorado, and Rattlesnake, New Mexico, crudes are to be processed. The site consists of 100 acres four miles from the heart of the city of Denver.

Cosden Oil Company Enlarging

Cosden Oil Company at its refinery three miles east of Big Spring, Texas, is enlarging to a rated capacity of 16,500 barrels through the installation of a new tube still of 6500 barrels capacity. Work on the foundation is under way and construction is to be rushed to completion.

Eastern Building Refinery in California

Eastern Oil & Refining Company, a recently formed corporation, will build a small refinery in the industrial district east of Los Angeles, work to start at once. The plant will be in operation within 30 days. Directors of the company are H. N. Willard, R. E. Canniff and V. H. Koenig.

Potrero Plants Completed

Edington-Witz Refining Company and Pan-American Oil Company have each completed natural gasoline plants in the Potrero field, near Los Angeles, the conventional absorption equipment having been used.

Empire Building New Gasoline Plant

The Natural Gasoline Division of Empire Oil & Gas Company has announced active construction of a natural gasoline plant in the new developed Wanette-Asher field, Oklahoma, Township 6, Range 3, which construction will make a total of 20 operating plants for the Empire companies. Distillation units, absorbers, compressors and other accessories are available in the Seminole area which will lend to the speed of completion of erection of the plant. The initial capacity is reported at 10,000,000 cubic feet, with provision made for additional units as the field develops.

Fields Process

The Fields Chemical Company of 1202 Financial Center Building, Los Angeles, has been incorporated for the purpose of utilizing the Fields process, which it owns, in the manufacture of synthetic gasoline from refinery bottoms, low grade oils, and waste organic materials. John D. Fields, the inventor of the process, is president and general manager of the company; Walter W. Allen is executive vice-president and secretary, and Max E. Socha, vice-president of the Bank of Commerce of Los Angeles, is treasurer.

Globe Combination Unit Operating

Globe Oil & Refining Company, at its Lemont, Illinois, refinery has completed construction of a 6000-barrel combination skimming and cracking unit of the Winkler-Koch type and has begun operations. The new unit practically doubles capacity of the refinery and its output of gasoline. D. B. Kelly is in charge of operations at Lemont.

Gulf Enlarging Fort Worth Refinery

Gulf Refining Company plans installation of additional equipment at its Fort Worth refinery at Drennan Avenue and Keller Road. Reported cost, $200,000.

Houston Oil Company Plans Refinery

Houston Oil Company of Texas for some time has been planning a refinery at Corpus Christi where work is now under way in the construction of a tank farm of 55,000-barrel tanks. The tank farm is to be connected by pipe line with

the company's producing properties in Bee, Refugio and Webb Counties. The project calls for a refinery and tidewater shipping terminal.

International Moving Plant

International Refineries, which formerly operated at Camarillo, is moving its equipment to Hynes, California, where it controls the old Perfection refinery. Lubricants will be made as soon as the necessary equipment is assembled. The plant has been making road oil, but will change its runs to meet market requirements, probably manufacturing both road oil and lubricants.

MacMillan Building Refinery

MacMillan Petroleum Corporation is building a new refinery of 2500-barrel capacity at Norphlet, Arkansas, in the Smackover field, to handle selected heavy Smackover crude. The new plant will be ready for operation by September 15. It will be a finishing plant for naphtha, furnace oils, and a full line of lubricating oils and asphalts. The company's plant at El Dorado of about 1800 barrels capacity will be dismantled upon completion of the new project. De Ralph Frizell, at present in charge of operations at the El Dorado plant, will have charge of the new unit. The company will continue its sales offices at El Dorado in charge of T. A. Hosey. Construction is in charge of C. C. Benz, construction engineer, from the Los Angeles office of the MacMillan Petroleum Corporation. The Boner and Shelton process, the patent on which is owned by the MacMillan Petroleum Corporation, will be used in the plant.

Carbon Black Plant in Oklahoma

Oklahoma Corporation Commission has granted permission for the construction and operation of a carbon black plant to Fred L. Coogan of Sayre, Oklahoma. This manufacturing plant will be located in the vicinity of the Sayre field. Consolidated Gas Utilities Company and Western Counties Gas Company are taking gas from the Sayre field amounting to approximately 6,000,000 cubic feet per day. Daily production in the field is reported at approximately 600,000,000 cubic feet.

Ohio Building Plant

Ohio Oil Company is completing a natural gasoline plant in the Venice-Playa del Rey field to handle gas from its own and perhaps other wells. Like most California plants, absorption methods will be employed. Although wells in this field have a low gas-oil ratio, the gas contains a high percentage of gasoline. The plant is located on the Recreation Gun Club lease and has a rated capacity of 5,000,000 cubic feet of gas daily.

Gyro Units in England Completed

Petroleum Refineries, Inc. has completed construction of its new refinery at Killingholme, near Hull, Yorkshire, England with a cracking capacity of 4000 barrels daily. The plant was to be in operation in June, 1930, and employs the Gyro vapor phase cracking process. Beginning of construction work was reported in the Refiner and Natural Gasoline Manufacturer in July, 1929, page 138. The operating company was organized for the purpose in conjunction with Low Temperature Carbonization, Ltd. and other interests, and although petroleum will be treated in the ordinary manner the company expects to concentrate on the cracking of low-temperature tars, expanding this phase of operation as rapidly as the tar becomes available for treatment. These are the first Gyro units to be erected in Europe. Canada McColl Frontenac Company is using the process. Pure Oil Company is operating Gyro units at all of its refineries in this country, and Carbide and Carbon Chemicals Corporation is operating one unit at South Charleston, West Virginia.

Phillips Petroleum Purchases Panhandle Plant

Phillips Petroleum Company has purchased the natural gasoline plant of the Dixon Creek Oil Company located in Section 14. Y. M. & C. Survey, Hutchinson County, Texas. The plant is absorption type with a 15,000-gallon rated daily capacity. The plant will be operated for the time being by Phillips Petroleum Company.

Phillips Building at Hobbs

Phillips Petroleum Company announced early in June that construction work would proceed at once on the erection of a well pressure absorption natural gasoline plant in the Hobbs field, Lea County, New Mexico, where gas averaging about two gallons recovery per 1000 cubic feet is becoming available in large quantities. The proposed plant will be equipped to handle 50,000,000 cubic feet of gas daily, with an estimated recovery of 40,000 gallons. The initial cost is placed at $750,000. The company is not a producer in the Hobbs field, and is making long term contracts for gas. The residue gas will probably be turned to a carbon black manufacturer. Railroad facilities are not available in the Hobbs area.

Pratt, Knox Plant at Earlsboro

Pratt, Knox, Inc., is erecting a new natural gasoline plant in the Earlsboro pool of the Greater Seminole area, Oklahoma. This plant is to produce 10,000 gallons of gasoline daily and is planned to be in operation in August. Warren Petroleum Company has contracted for the output of the new installation.

Pure Adding Gyro Units

Pure Oil Company is adding Gyro vapor phase units at two of its plants. At the Heath, Ohio, plant construction work on two new 1000-barrel complete Gyro units is well under way with R. P. Wood of the engineering department in charge. Work on the additional tankage required is about completed. At Muskogee, after some months of operation only, construction work is starting on another Gyro unit and additions to the Petroleum Chemical Corporation's butylene manufacturing equipment. A new method going in is expected to increase the butylene production about 40 per cent. The change involves conversion from compression to absorption methods. At Marcus Hook, Pennsylvania, the company has completely remodeled its No. 4 Cross still and placed it back on stream, securing an increased yield of gasoline.

Belgian Cracking Plant Operating

Raffinerie Nationale de Petroles, S. A., has completed construction of its Jenkins cracking plant at Terdonck, near Ghent, Belgium. Plant construction has been supervised by E. Kroch, D. Sc. Plant capacity is reported at 1200 barrels daily.

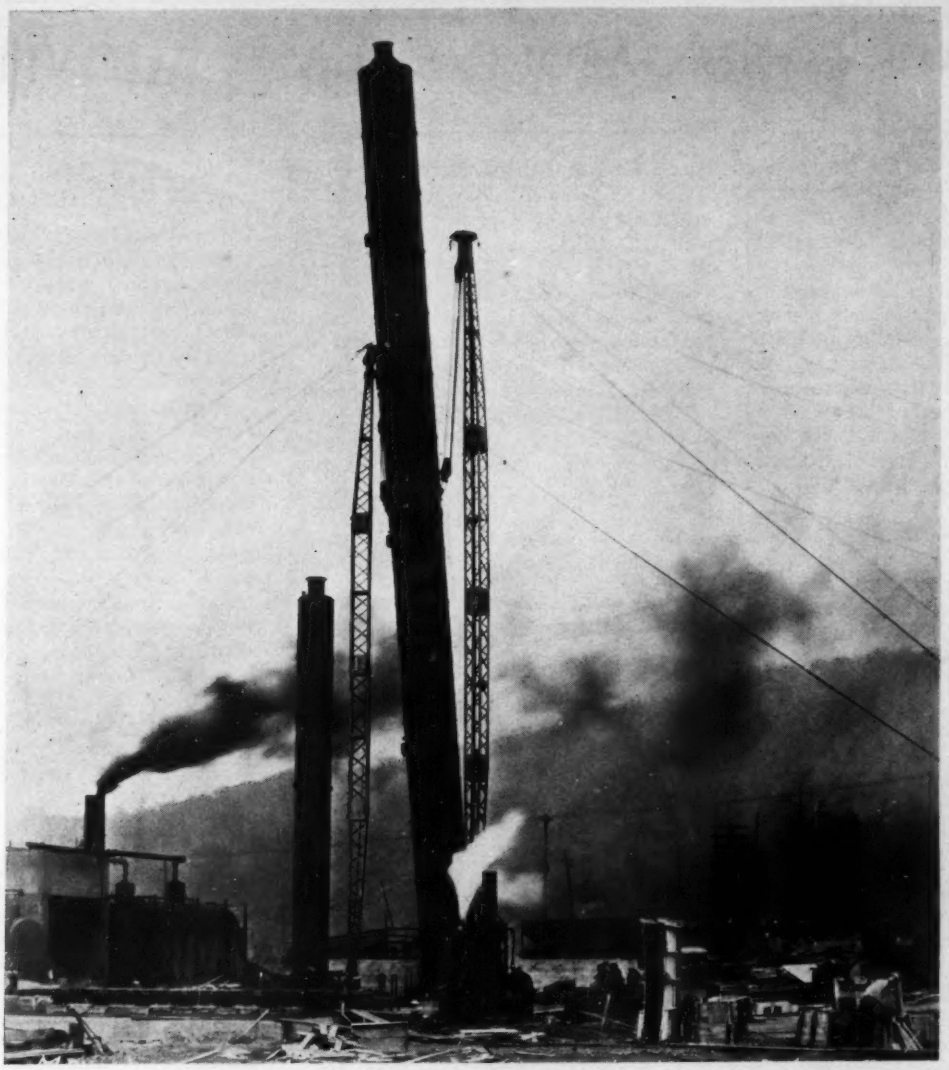
Roosevelt Plant Operating

Roosevelt Oil Company started operating its refinery at Mount Pleasant, Michigan, late in June. This company, which was recently organized, moved the plant from Muskegon, where it was operated as the Michigan Central Refining Company and required but 50 days to dismantle the equipment, move it and get started operating on the new site. The capacity is reported at 3000 barrels daily. T. F. Caldwell is in charge of operations. R. B. Hovis is plant superintendent.

Royal Dutch Gets Hydrogenation

The Royal Dutch Company has entered into contract with Standard Oil Company of New Jersey and I. G. Farbeindustrie to participate in the development and utilization of the hydrogenation patents and to pool its interests with this group, according to the annual report of the Royal Dutch Company for 1929. The report states "By combining with other interested parties, some of which are large chemical industries, all further inventions and improvements will be concentrated in one central body, and thus the process of hydrogenation can be applied on the widest possible scale."

Commenting on this statement by Sir Henri Deterding, Standard Oil of New Jersey has made the following announcement: "These negotiations were carried on by the foreign interests of Standard Oil Company of New Jersey and have resulted in the working out of a plan by which the Royal Dutch-Shell group will acquire a participation in the foreign



Fractionating Tower for a 3000 Barrel Distilling Unit

Fractionating towers for a complete Foster Wheeler distilling unit are here shown during erection. The large atmospheric tower will continuously recover to specification gasoline, from the top of the tower, six liquid side streams and bottoms to varying market conditions. The rerun tower at the left is arranged for the removal of an overhead vapor, one liquid side stream and bottoms, and has sufficient flexibility to rerun the de-waxed products from the large unit.

The side streams from Foster Wheeler fractionating towers are brought to specification by a special type Weir control valve, which maintains a constant ratio of reflux to ascending vapors at the point of side stream removal. This valve functions independently of the thruput, variation in the tube still temperature or pressure fluctuations within the tower. A special type of internal stripping section insures close fractionation between each product. Due to the inherent characteristics of the Weir valves in combination with the internal stripping sections, manual operation of the side stream control is never necessary unless it is desired to change the specification of the side stream products.

Foster Wheeler distilling units possess a high degree of flexibility which permits running to side streams of varying specifications or for refining different crudes.

FOSTER WHEELER CORPORATION

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Foster Wheeler, Limited: London, England
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FOSTER WHEELER

REFINERY AND GASOLINE PLANT ACTIVITIES

patents relating to the hydrogenation process. Under this plan it is expected that there will be applied in the principal nations abroad the same general system of licensing which is now being worked out in the United States, providing for the control of the patents in each country by a local group made of those interested in their development and use in that country. Included in this arrangement will be a complete exchange between foreign and domestic users of the hydrogenation process, of the technical information, and of the right to use improvements.

"The Royal Dutch-Shell interests which comprise the only foreign petroleum organization operating in this country on a substantial scale, will participate in the proposed plan for licensing in the United States on the same basis as other oil companies operating here. They will have no interest, however, in United States patent rights save that acquired through such participation."

According to an article appearing in the New York Times the place of the hydrogenation process is to be that of a balance wheel, a rectifier to prevent excess production of any one grade of gasoline and a remover of impurities from crude stocks.

Vapor Phase Agreement

The Royal Dutch-Shell group has signed a contract with the Petroleum Conversion Corporation for the use of its process on a non-exclusive basis in the United States and formed a subsidiary company to take over the non-American rights, according to a recent item in Petroleum Times, London. Shell Petroleum Corporation, St. Louis, began erecting a True Vapor Phase unit in August of 1929, which unit is soon to be placed in operation. The reported capacity is 10,000 barrels daily, which would make it the largest cracking unit in the industry. The Petroleum Times states "The Royal Dutch group is further cooperating in exploiting the process throughout the world, and a Dutch company has been formed, under the name of General Patent Company, to take over the non-American rights. Half of this company is owned by the Petroleum Conversion Corporation and the other half is owned by Bataafsche Petroleum Maatschappij.

Seaboard Plant At Venice

The Seaboard-Midland Petroleum Corporation of New York has established a California office at Los Angeles and will operate at Venice under the name of Del Rey Oil & Refining Company. This organization has plans under way for immediate construction of a natural gasoline plant to handle gas from Venice wells. The company is also considering the building of a refinery at some future date. Meanwhile, this refining and exporting company is purchasing and storing oil.

Shell Group Builds Nitrogen Plant

Shell Chemical Company has been organized as subsidiary to Shell Oil Company of California and has purchased 600 acres in Contra Costa County, California, to be used as the site for a nitrogen fixation plant to cost approximately $5,000,000. Nitrogen obtained from the atmosphere will be combined with hydrogen under pressure and in the presence of a catalyst to form ammonia. The hydrogen will be secure from natural gas. Ammonia and its oxidation product, nitric acid, will be utilized in the preparation of fertilizer. The process was perfected after exhaustive research by the development department of Shell Oil Company.

Signal Plant at Big Lake

Signal Gasoline Company, which is owned by Group One Oil Corporation, a subsidiary of Continental Oil Company, and Signal Oil & Gas Company of Los Angeles, is erecting its second natural gasoline plant in the Big Lake field of Reagan County, Texas. Rated capacity is 35,000,000 cubic feet, and the plant is to process natural gas from the 8500-foot production level in this field. Recently announced plans of a company contemplating erection of a carbon black plant in this area are apparently not to be carried out, but Big Lake Oil Company is constructing a small experimental carbon black plant which may be the forerunner of a larger installation.

Skelly Oil Company Plans Expansion

Skelly Oil Company has announced a two-year expansion program following the sale of $12,000,000 of six per cent preferred stock, which program includes all branches of the company. At the El Dorado, Kansas, refinery a new lubricating oil plant is to be erected in addition to other additions and improvements. The company is also considering erection of a 5000-barrel combination skimming-cracking plant in the Panhandle of Texas, near Pampa.

Standard of Ohio Adds Unit

Standard Oil Company of Ohio, Cleveland, is constructing a new distillation unit at its No. 2 plant on East Sixty-fifth Street. The company engineering department is in charge.

Sullivan Refinery Sold

Sullivan Refineries, Inc., refinery at Dayton, New Mexico, has been purchased by Stephen Lanning and associates of Inglewood, California. Plans call for the rebuilding of the plant which has been idle for several years, and placing the equipment in operation to process crude from the Twin Mounds pool, southeast of the Artesia field.

Gulf to Build Refinery at Pittsburgh

The Union Gulf Corporation, a subsidiary of the Gulf Oil Corporation has purchased 120 acres of land on Neville Island, in the Ohio River, near Pittsburgh, and plans to start construction of a major refinery there at once. The plant will be the eastern terminal of the pipe line to be built from eastern Oklahoma. Initial capacity of the Pittsburgh refinery is reported at 3000 barrels per day, and the plant is to be equipped with cracking facilities. The company is also reported negotiating for a site near Cincinnati where a second new refinery is to be located. The Pittsburgh and Cincinnati plants will be connected by pipe lines to the recently purchased refinery at Toledo formerly owned by Paragon Refining Company. Other Gulf Oil Corporation refineries are located at Port Arthur, Texas, Sweetwater, Texas, Fort Worth, Texas, Bayonne, New Jersey, and Marcus Hook, Pennsylvania.

Non-Metallic Linings Bulletin

Universal Oil Products Company has issued a progress report on research work aimed at the protection of refinery equipment from corrosion, under the title "Protecting Cracking Vessels with Non-metallic Linings" by Dr. J. C. Morrell. Copies of this report may be secured free by addressing the company at 310 South Michigan Avenue, Chicago, Illinois.

Wolverton Refinery at Olney Texas

Wolverton Refining Company began construction work early in June on a skimming plant on the east side of the town of Olney, Texas, and will obtain its crude supply from independent operators and companies in the Olney townsite field. The plant is to be provided with equipment to handle 750 barrels of crude daily. Chas. T. Wolverton, Jr., formerly identified with the Olney Oil & Refining Company, is head of the new concern. S. J. Marcell is also identified with the project. Headquarters of the company have been established at Olney.

British refining progress has been such as to surprise the natives, according to a correspondent who recently visited the plant of Agwi Petroleum Corporation, Ltd., at Fawley, near Southampton. While the industry of oil refining in England and Scotland has been of comparative recent birth, he says, its progress has certainly come as a surprise to many who doubted the advisability of its establishment. Not only does the industry give employment to thousands of British laborers but it is also helping to build British manufacture in numbers of ways.

New Equipment for the Modern Plant

McDonald Tank Vent

Aluminum Truck Tank Cap and Vent

A. Y. McDONALD MANUFACTURING COMPANY

A. Y. McDonald Manufacturing Company, Dubuque, Iowa, is now marketing a new aluminum lightweight truck tank cap and vent, in keeping with this company's policy of keeping down the weight of truck tanks. It weighs less than one-half as much as an iron cap and vent.

The vent is inverted to eliminated possibility of breakage in case the tank overturns. The vent inlet and outlet are underneath the handles to protect them against weather conditions. Two fusible plugs in top of the cap are to prevent explosion of the tank in case of fire.

The vent is especially designed to give the maximum venting area, the total venting area exceeding a full three-quarter-inch opening. It is the triplex type. A special screen is employed to prevent back flash, being held in place yet easily removable when necessary.

A. Y. McDonald Manufacturing Company's home office, shown above, or any of the company's branches at Omaha, Minneapolis, Des Moines, Kansas City, Lincoln, Denver, Sioux City, or a McDonald distributor will furnish more complete details upon request.

"Oilyness" Measure

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY

Westinghouse Electric and Manufacturing Comany's device developed for measuring the oilyness of oil is shown here being demonstrated in the laboratories at East Pittsburgh.

The device consists of a weighted platform supported by three highly-polished steel balls and resting on an equally highly-polished steel plate which is covered with a film of oil. The steel balls cut through the fluid film and rest on the tightly adsorbed film built up by certain molecules present in the lubricant. The plate is fastened to a hinged platform which is raised slowly by means of a crank.

Thus, the angle between the plate and the horizontal is increased gradually until the weighted platform supported by the steel balls moves, slipping over the absorbed film of molecules. The slightest movement of the platform is rendered perciptible by the action of a voltmeter connected in a circuit which is made when the platform comes in contact with a needle after moving only .001 inch. The tangent of the angle between the plate and the horizontal attained when the platform begins to slide is the coefficient of friction.

In this way, the device, determining the angle at which the balls will slide over their adsorbed film of lubricant molecules, measures the oilyness of the oil. Of course, the smaller this angle, the greater the oilyness and the better the oil for lubrication purposes.

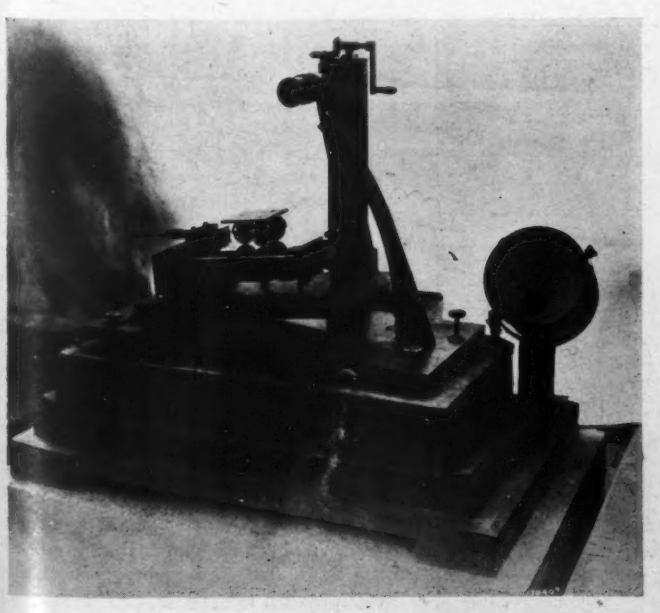
Lubrication System

HILLS-McCANNA COMPANY

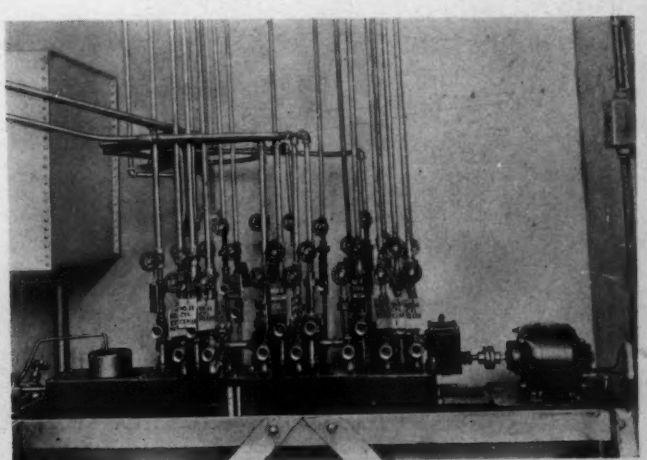
Hills-McCanna Company, 2349 Nelson Street, Chicago, announces the centrally controlled lubrication system, an installation of which is shown here. The equipment consists of one regular 24-pint 30-feed motor driven lubricator and one regular 22-feed motor driven lubricator. The two units combine to make a total of 52 feeds or "oil leads." Two 50-gallon storage tanks are provided to feed oil to lubricators by gravity in this installation. Sight glass oil level indicator and a float valve are mounted on the reservoir of each of the two lubricator units. The flow of oil is automatically regulated and fed from the large central supply tank. Replenishment of the oil supply to the lubricator reservoirs is mechanical and fillings are eliminated.

While operated by a single driving mechanism, each feed of the lubricating units is independent, and may be adjusted to deliver the desired quantity of oil the individual part requires. The amount of oil being fed to bearings or cylinders may be checked at any time by the "blinker" or sight feeding device mounted on each lead. All working parts are accessible and are mounted above the reservoir. The supply tank, feeds and oil lines are sealed against contamination of the oil supply by moisture or dust.

Each lead from the lubricators is tagged and oil is piped direct to each live roller and bearing. The system runs for months with but casual inspection. Each feed represents a separate pumping unit. Adjustments or regulations can be made without shutting down the plant.



Oilyness Measure



Hills-McCanna Lubricator

Recorder-Controller

THE FOXBORO COMPANY

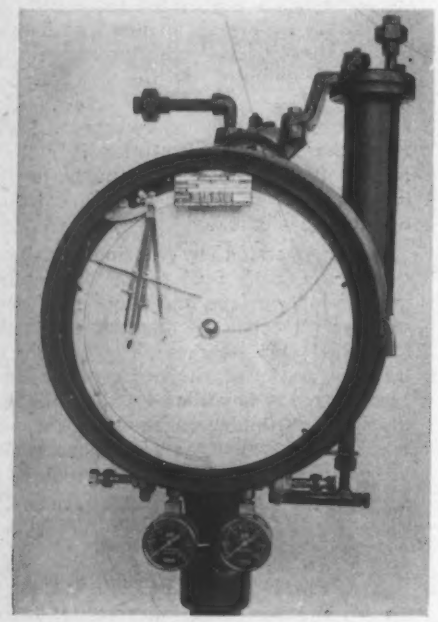
The Foxboro Company, Foxboro, Massachusetts, has perfected a new instrument called a differential limit recorder-controller. This controller, when working with the Foxboro gas meter in the type of installation shown here, will meter a flow that varies over the widest range.

When installed, this controller continually gives a record of the gas flow through the line. It is known as a primary meter. It is specified to handle the minimum rate of flow with commercial accuracy. When the differential range is exceeded, the control functions and automatically opens a valve which puts the secondary meter in operation. This secondary meter is a complete Foxboro gas flow meter operating in the by-pass. When the secondary meter goes into operation it doubles the effective capacity of the set-up.

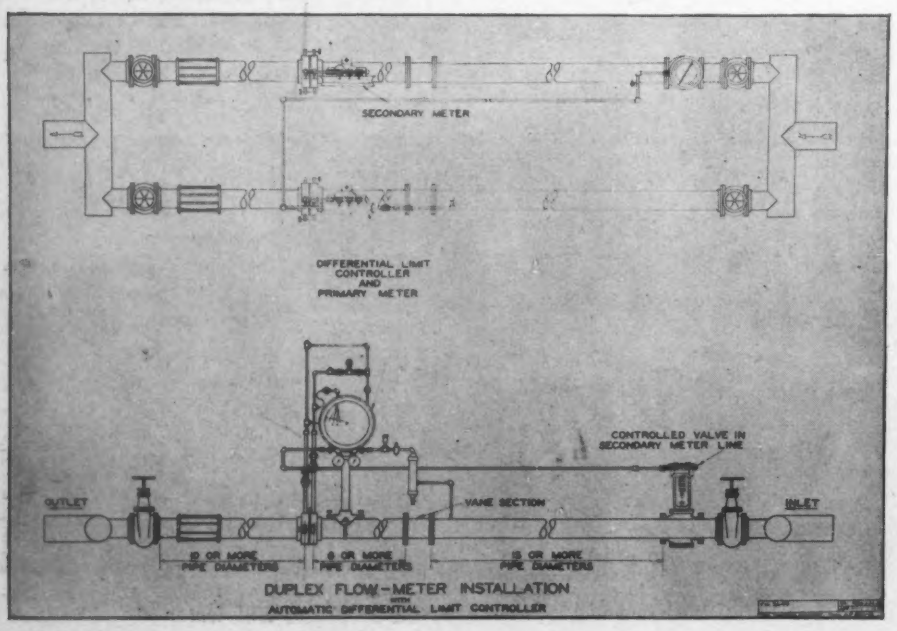
As soon as the secondary meter line is open the differential pressure drops, because of the increased capacity. The valve in the secondary meter line is held open by the controller until the flow is again within the capacity of the primary meter. The valve is then closed automatically and the primary meter again assumes the entire load. The operation is entirely automatic from start to finish.

Positive and flexible control is obtained by the fact that the points, at which the secondary meter is to be cut in and out of the line, can be set at will. Positive action and tight closing of the controlled valve are insured by having it operated by the gas line pressure or an auxiliary air supply of 15 pounds per square inch.

Single meters or wide-range meters or more than one by-pass may be installed in various combinations with the new Differential Limit Controller to meter all cases of varying flow.



Foxboro Recorder



Liquid Sampler

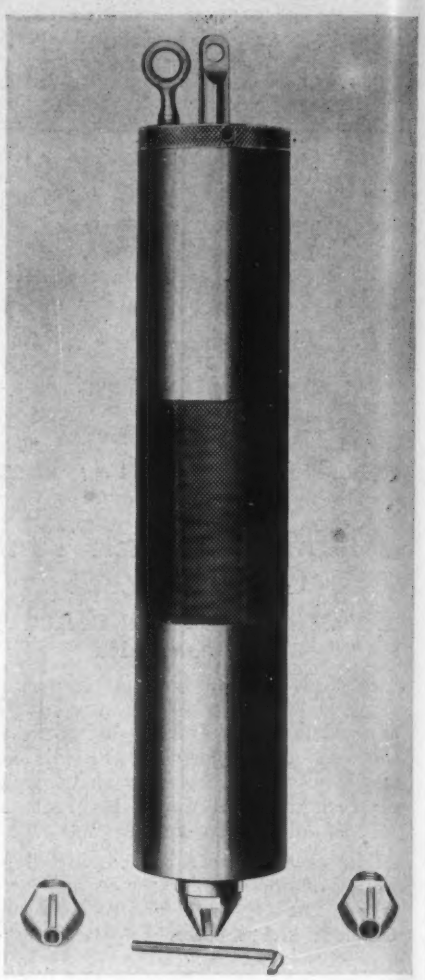
HILLS-McCANNA COMPANY

Hills-McCanna Company, 2349 Nelson Street, Chicago, announces the new liquid sampler which provides a means for obtaining an accurate, composite sample of practically any fluid. Samples from three levels of tanks or tank cars are obtained in a single operation.

This sampler operates on a single plunger suction principle. It consists of a hollow metal cylinder 13½ inches in length, made of non-sparking metal. A close fitting piston without packing operates on the inner wall of the cylinder. Interchangeable nozzles for handling liquids of varied viscosity are provided for the outlet in the lower end of the cylinder.

The sampler is lowered into the tank or vessel to the desired depth by means of a length of chain attached to the lower end. A second length is fastened to the plunger rod. This rod is notched at three equidistant points, dividing the cylinder into three parts of equal capacity. By drawing the chain attached to the plunger, liquid is sucked into the lower third of the chamber. The operator is informed when this portion is filled by contact of the upper notch on the plunger rod with a string ball set in the cylinder neck. The sampler is then raised to a second and third position where successive samples are obtained in the same manner, filling the sampler to its full capacity of 32 ounces. The operation has then obtained an average, composite sample of the contents from the extreme bottom, middle and upper portions of the vessel. By analyzing this sample the exact quality of the liquid is determined.

Further deails are available by writing the company at the address given above.



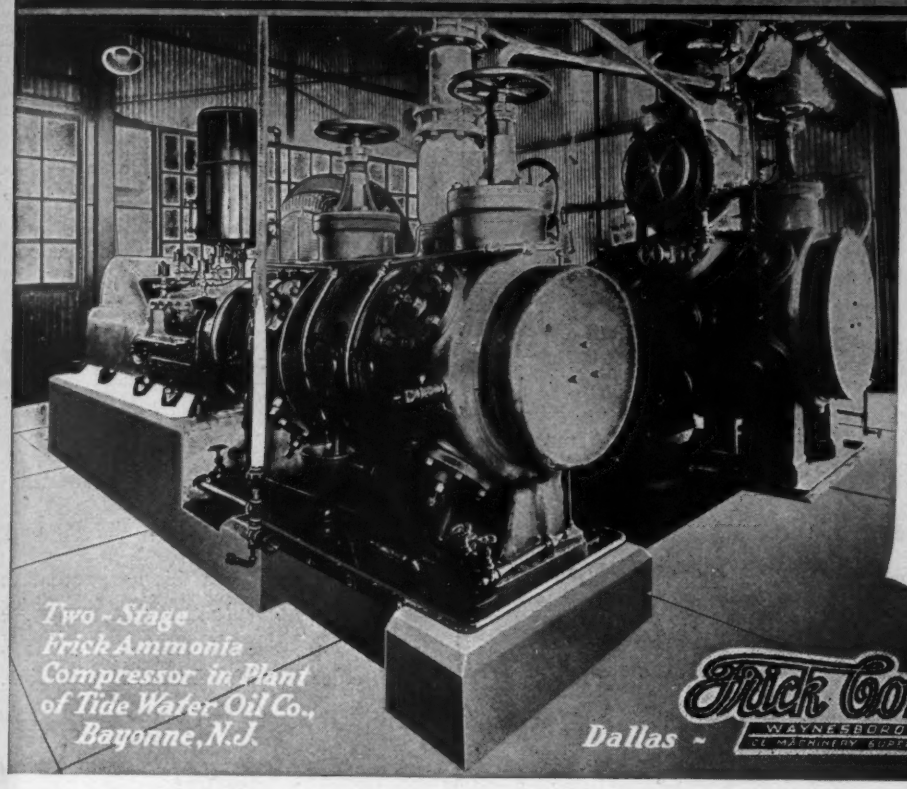
Hills-McCanna Sampler

Electric Cut-Off Valve

CHARLOTTE CHEMICAL LABORATORIES

Charlotte Chemical Laboratories, Charlotte, North Carolina, is introducing the new Caroline electric cut-off valve, which is used for automatically cutting off the supply of oil, water, gas, steam or other liquids and gases when the power goes off. It is also designed for use in conjunction with pyrometer and thermometer systems for cutting off supply when tem-

FRICK REFRIGERATION



Two-Stage Frick Ammonia Compressor in Plant of Tide Water Oil Co., Bayonne, N.J.

—25°

TRADE FRICK MARK

—50°

For Low Temperatures

Having built and installed all types of cooling plants for industrial purposes, handling temperatures down to 50 and even 109 deg. below zero Fahr., we are in position to solve your special cooling problems with Frick Refrigeration. You are invited to use our 48 years experience in this work.

Write, wire or 'phone.

Dallas - Frick Company WAYNESBORO, PA., U.S.A. "Machinery Superior Since 1883" - Kansas City

PIONEER*—One who goes before and opens the way.

***Worcester's Dictionary.**

PIONEER OYSTER-SHELL LIME

goes before **all others—being the only lime of its kind in the world.**

It *opens the way* to definite and decided economies in all refinery operations, by reason of its special properties and unusual purity.

Samples and full information on request.

THE HADEN LIME COMPANY

MFRS. OF PIONEER OYSTER SHELL LIME

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HOUSTON-TEXAS

U. S. A.

For cracking process in oil refineries we furnish Aluminum Armored Asbestos filled Gaskets and Corrugated Armco Iron or Monel Metal Asbestos encased.

Copper rings 3/16" thick for 4 and 5" O. D. tubing.

Washers or gaskets made of Aluminum, Copper and other Metals.

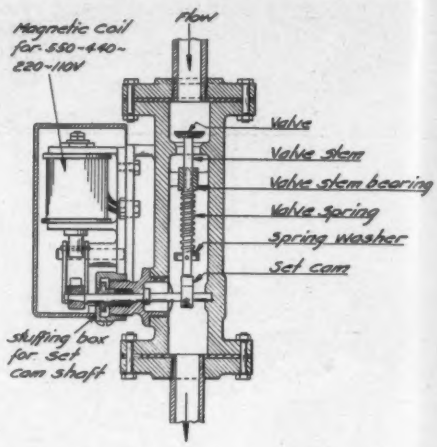
Write for Prices.

METALLO GASKET CO.

NEW BRUNSWICK, N. J.

peratures read predetermined high and low points.

When a trip lever operates the pressure in the supply lines assist in closing and keeping tight the valve. The only stuffing box used is for the cam pin which



means that stuffing box friction and leakage is eliminated.

This valve is made in all necessary sizes.

Complete details on this new automatic cut-off valve may be obtained by writing the home office of Charlotte Chemical Laboratories, given above, or to the New York office, 50 East 42 Street, New York.

PULMOSAN CHEMICAL CARTRIDGE RESPIRATOR

99.7% Efficient!

When you buy the PULMOSAN Chemical Cartridge Respirator, you buy the *most efficient* type as revealed by *official test.*

In addition to safety factors, the PULMOSAN has many improved features insuring maximum comfort, durability and economy.

PULMOSAN is also equipped to supply you with:

Asbestos Outfits — **Non-Sparking Tools**
Gas Masks — **Fire Extinguishers**
First Aid Equipment, etc., etc.

Complete details on request.

Pulmosan Safety Equipment Corp.

182 Johnson Street,
BROOKLYN

PULMOSAN SAFETY EQUIPMENT CORP.
176 Johnson St., Brooklyn, N. Y.
Gentlemen:—Send us details on your respirators and other safety equipment for refineries.

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Address .....
City .....
State .....

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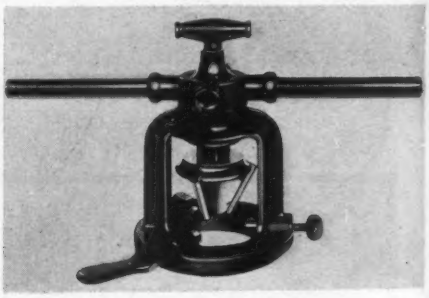

Small Pipe Reamer

Small Pipe Reamer

OSTER MANUFACTURING COMPANY
WILLIAMS TOOL COMPANY

Oster Manufacturing Company and Williams Tool Company, Cleveland, have placed on the market a new pipe reamer for small pipe, designated No. 414 reamer.

An outstanding feature offered in this reamer is that it has a screw feed, the pitch of which is designed so that great pressure is exerted by the reaming blades. This feature eliminates the necessity of pushing against the tool to obtain sufficient pressure for a thorough reaming job.

Number 414 reamer was designed primarily to be used with the Oster No. 414 Power Boy, but provision has been made so that two additional handles may be used for hand operation.

There are three reaming blades, made so that they can be replaced if necessary. The body of the tool is made of certified malleable iron.

General Refractories

Spells True Economy

Economy—because you can actually measure the savings in reduced refractory costs due to increased lining life and fewer shut-downs for repairs.

The uniformly high quality of General Refractories products is recognized throughout the world by refractory users in smelting and refining plants, iron and steel plants, cement and lime plants, power plants, gas plants, etc.

Highest grade refractories, correctly applied to your individual requirements — that's General Refractories service.

GENERAL REFRACTORIES COMPANY

106 South 16th Street, Philadelphia, Pa.

District Offices: Birmingham, Boston, Buffalo, Chicago, Cleveland, Detroit, Indianapolis, New York, Pittsburgh, St. Louis, San Francisco.
Representatives: Seattle, Montreal, Havana, Cuba.

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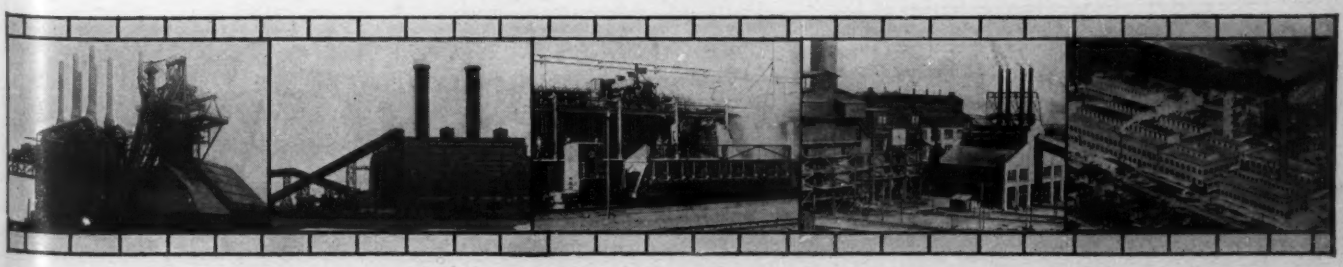

Sales Representatives Wanted

Conscientious sales representatives are offered an exceptional opportunity to sell an absolutely incombustible steel paint to large industrial users. Practically non-competitive and virgin field in Oil Refineries, Utility Corporations, Railroads, Smelting Refineries, etc. Representative's territory protected. Commission extremely liberal. Write, outlining your qualifications to cover above fields, to Box 9095, care Refiner and Natural Gasoline Manufacturer, Houston, Texas.

Electrically Driven Centrifuges
Hand Centrifuges
WRITE
WILLIAMS, BROWN & EARLE, Inc.
Manufacturers of Laboratory Apparatus
918 Chestnut St. Philadelphia, Pa.

TANK CARS BOUGHT, SOLD, LEASED AND REPAIRED
Repair Parts (including whole trucks) for tank and freight cars of all kinds.
RAILWAY CAR & EQUIPMENT CORPORATION
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"A trial is all we ask"

DOME COVERS AND OUTLET CAPS

Made to A. R. A. Specifications. Instant shipping service. Write, phone or wire.
Western Iron & Foundry Co., Wichita, Kan.

Will Sacrifice New Material

253—4" x 8" Center Drop Forge Steel Return Bends Without Aluminum Bronz Plugs.

10—4" Drop Forge Ells Without Aluminum Bronz Plugs.

For information regarding this material

Address: Box 2003, Tulsa, Okla.

Attention CHAS. F. SMITH

Ljungström AIR PREHEATER
CONTINUOUS REGENERATIVE COUNTERFLOW
Write for literature.
AIR PREHEATER CORPORATION
40 E. 34th St. New York

VALDURA PAINT
Closing Out Stock—Dealer will sacrifice for quick sale all or part 600 gallons Valdura Paint. First class condition. Opportunity for great saving to dealers or users. Subject to prior sale. Address Box 5645, car Refiner and Natural Gasoline Manufacturer, Houston, Texas.

ITEMS ABOUT MANUFACTURERS

American Rolling Mill Company, Middletown, Ohio, has published a 64-page booklet titled "A Visit to Armco With the Iron Master." It is based on the talk given by the Iron Master during recent radio programs of the company, and contains an illustrated story of a visit to the Armco plant. A copy is available upon request.

The Hays Corporation, Michigan City, Indiana, announces a new flue gas analyzer and portable combustion test set catalog, No. TSE-30, which will be mailed to interested persons upon request. It is a 20-page, two-color booklet, fully illustrated, and complete with charts on operations.

E. D. Bullard Company, manufacturers of safety equipment and material, announce the publication of a new catalog entitled "Everything in Safety," Catalog No. 30. This catalog contains 144 pages and in addition to picturing and describing a complete assortment of safety material and equipment for all industries, contains working information and data of interest and of value to all interested in safety work. A copy of this new catalog will be sent upon application to any individual giving his name, address, and business connection.

Neilan, Schumacher & Co., Los Angeles, manufacturers of automatic control and regulating equipment, announces through its president, Thomas J. Neilan, that the firm will hereafter be called Neilan Company, Ltd., as A. F. Schumacher, formerly vice-president, has retired from the business. The new company will continue to use the trade name of "Neilan" on all its control equipment but its cable address will be changed to "Neilanco" — Los Angeles. Mr. Neilan, accompanied by his wife, is on a business survey tour of the various offices of Neilan Company representatives. His trip will take him to all the major oil field distribution centers of the country.

THOMAS J. NEILAN

Goulds Pumps, Inc., Seneca Falls, New York, has published a new handbook covering every phase of centrifugal pump from theory to installation and operation. It is "The Centrifugal Pump," compiled by F. G. Switzer, professor of hydraulic engineering, Cornell University. In a chapter devoted to testing the reader is taken through a modern testing laboratory and shown, step by step, how centrifugal pumps are inspected and put in perfect operating condition before leaving the factory. Copies of this bulletin will be mailed upon request for Bulletin No. 401, sent to the above address.

Interstate Drop Forge Company, 27th Street and Capitol Drive, Milwaukee, has issued a bulletin on heat treatment of forgings, which is educational in its discussions. An instructive chart of heat treatment record is included and the bulletin is replete with heat treatment tables. A copy is available upon request.

Tube-Turns, Inc., Louisville, Kentucky, announces the appointment of six new distributors for its line of seamless, short radius forged fittings for pipe welding. These distributors are: Grinnell Company, Charlotte, North Carolina, for North Carolina, South Carolina and Georgia; Ebbert & Kirkman Company, Inc., of Birmingham, for Alabama; B. Hoffmann Manufacturing Company of Milwaukee, for Milwaukee and adjacent territory; United Pipe & Supply Company, of Charleston, West Virginia,

SALES ENGINEER
For piping and pipe materials. Prefer man who has had experience in refinery operation and understands oil industry requirements. Territory to be covered is Texas and bordering states. Give detailed sales experience, references, and salary requirements. Add. Box 789 care of Refiner & Natural Gasoline Manufacturer, Houston, Texas.

Refinery equipment today requires large quantities of grating and treads.

ARROWHEAD has kept apace with the increasing demand and furnishes grating and treads for every requirement in the refinery industry.

ARROWHEAD GRATING AND TREADS are strong, non-slippable and serviceable under any condition, either interior or exterior.

Write for our handbook.

ARROWHEAD IRON WORKS, INC.
431 W 5th St.,
KANSAS CITY, MO.

Certainty of Operation

CONTINUOUS 24-hour plant operation puts a premium upon certainty of operation of apparatus. For this reason, the large oil company in whose plant this photograph was taken has selected De Laval Pumping Equipment, and two of the pumps shown may be driven by either an electric motor or by a De Laval velocity stage turbine. One has a capacity of 5,000 gallons per minute against 173 ft., at 1200 r.p.m., and the other 1800 gallons per minute against 290 ft. head, at 1800 r.p.m. In addition, there are three motor driven pumps, one having a capacity of 1800 gallons per min. against 290 ft. head at 1800 r.p.m., and the other two delivering each 5000 gallons per min. against 173 ft. head at 1200 r.p.m.

De Laval Pumps are built to limit gages on an interchangeable basis throughout, and all parts can be replaced by unskilled men, as new parts ordered from the factory do not require to be fitted. Efficiency, head delivery, and other characteristics are guaranteed and are verified by tests at the Works before shipment.

Ask for Catalog C-116

De Laval
Steam Turbine Company
Trenton, New Jersey

Local Offices: Atlanta, Boston, Charlotte, Chicago, Cleveland, Duluth, Havana, Honolulu, Houston, Kansas City, Los Angeles, Montreal, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., St. Paul, Salt Lake City, San Francisco, Seattle, Spokane, Toronto, Vancouver,

728

Manufacturers of Steam Turbines, Centrifugal Pumps, Centrifugal Blowers and Compressors, Flexible Couplings, Double Helical Speed Reducing Gears, Worm Gears, Hydraulic Turbines and Special Centrifugal Machinery.

PERMISSIBLE
TANK GAUGERS' MASKS

After months of arduous research in our laboratories we are now able to offer a Permissible, Bureau of Mines Approved Canister on All M-S-A Tank Gaugers' Masks for Protection against Organic Vapors and Acid Gases, including Deadly Hydrogen Sulphide Gas from Sour Crudes and Distillates. This announcement is of special importance to the Oil Industry.

TWO TYPES OF MASKS AVAILABLE
DETAILS ON REQUEST
USE THE COUPON

"Everything for Mine and Industrial Safety"

Mine Safety Appliances Co.

Braddock, Thomas and Meade Sts., Pittsburgh, Pa.

MINE SAFETY APPLIANCES CO.
PITTSBURGH, PENNA.

Without obligation, please send me copy of Bulletin No. 104 on M-S-A TANK GAUGERS' MASKS.

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POSITION_____

COMPANY_____

ADDRESS_____

The Spiral Motion Is the Trick

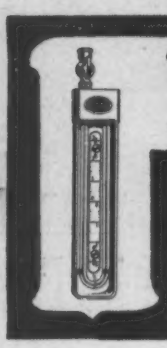
That's why Hood's Chemico Spiral Packing Rings have been selected by so many engineers. The center hole prevents choking and clogging.

Made of acid-resisting shale—practically indestructible.

Used by all big producers because of the intensive movements.

Samples on request

B. MIFFLIN HOOD CO., DAISY, TENN.



Manometers

THE MERIAM CO.

1954 West 112th St., Cleveland, Ohio

NOT TOO HOT

To revivify used fullers earth heat it just hot enough, but not too hot, and hold it there just long enough, but not too long. Really quite simple. The Nichols Herreshoff Furnace accurately controls both temperature and time, with the result that earth is maintained at high efficiency for long periods of service.

G. G. Brockway Company, Inc.
WARREN, PA.

KERLOW GRATING

FLOORS, STAIRS *and* LADDERS

KERLOW STEEL FLOORING COMPANY
220-22 CULVER AVE., JERSEY CITY, NEW JERSEY

for that city and adjacent territory; Vulcan Copper & Supply Company, of Cincinnati, for that city and adjacent territory; and Hedley & Voisinet, of Buffalo, for that city and adjacent territory. Each of the new distributors are carrying complete stocks of tube-turns.

A. O. Smith Corporation has announced the present capacity of the plant as 32 miles per day of large diameter oil and gas line pipe.

De Laval Steam Turbine Company, Trenton, New Jersey, has issued a booklet titled "New Water-Supply for Fort Lauderdale," which is the title of a paper written on a new water work system, comprising processes designed to get rid of color, taste, hardness and deposits in services and meters and to control the bacterial content, including deaeration, chemical treatment, mechanical agitation for mixing, sedimentation, carbonation, filtration and chlorination. This paper was reprinted by the De Laval Steam Turbine Company from Engineering News Record and is being distributed upon request to the Trenton office.

Tube-Turns, Inc., Louisville, Kentucky, is now making additions to its plant which will increase production of tube-turns by 60 per cent, according to an announcement from Walter H. Girdler, president of the Girdler Corporation, which operates the Tube-Turns Company. These products are seamless forged, short-radius, uniform wall fittings for pipe welding. Construction of the addition to the factory was scheduled for July 1, and the new equipment ready for operation August 1, the announcement states. Tube-Turns, Inc., has extended its markets to Hawaii, Canada, Central and South America, and a chain of 44 distributors and branch offices distribute Tube-Turns in this and other countries.

L. H. Brendel, advertising director of Neilan Company, Ltd. (formerly Nielan, Schumacher & Co.), manufacturers of automatic control and regulating equipment, Los Angeles, recently returned from an extended vacation spent in the region of the Grand Canyon and in Northern Arizona. Mrs. Brendel accompanied him.

Worthington Pump & Machinery Corporation, 2 Park Avenue, New York City, and Harrison, New Jersey, recently mailed a four-page loose-leaf folder announcing a new horizontal duplex steam driven heavy service pump for oil. This is the California pattern, 12, 18 and 24-inch stroke. It is for operating pressures up to 600 pounds and made in capacities ranging from 50 to 220 gallons per minute. Bulletin W-112 B1 gives a complete outline on these pumps, with illustrations, specifications and a table covering sizes and data. The company will forward a copy of this bulletin upon request to either of the offices shown above.

Rapid Construction Company, 5631 South Riverside Drive, Los Angeles, has a new catalog embracing an entirely new idea for the prevention and control of fires, especially oil fires. It is the first catalog ever written on the use of water in fog form as a destroyer of fire. According to the contents of this catalog, the Rapid equipment described will, by the conversion of water into millions of fine fog particles, destroy fire or conflagration in short time. This includes fires in derricks, tanks, refineries, etc. A copy of this new catalog on the Rapid fire prevention and protection equipment will be forwarded upon request to the address above given.